# USABILITY TESTING OF A MOBILE TECHNOLOGY FOR CHILDREN WITH HIGH-FUNCTIONING AUTISM SPECTRUM AND ATTENTION-DEFICIT/ HYPERACTIVITY DISORDERS

by

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# ABSTRACT

Children with attention-deficit/hyperactivity disorder (ADHD) and high-functioning autism spectrum disorder (HFASD) have organizational skills deficits. Organizational skills include the ability to manage materials (e.g., belongings, books, homework) and temporal skills such as organizing, planning, and managing tasks to completion. This study was a usability test of a prototype mobile technology designed to improve organizational skills. The prototype was assessed for usability and feasibility for future development.

A field-based mixed methods usability test was conducted. Sixteen children with ADHD and HFASD aged 8 to 12 years and their parents participated. The study was conducted in an 8-week summer treatment program. The usability test lasted 15 days, with data collected via observation, child and parent daily logs, surveys, and focus groups.

During the usability test, children brought the prototype technology to camp 95% of the time and used it to record items to bring to camp 85% of the time. Parents completed a daily log simulating mobile functions 88% of the time. Using the prototype device for homework tracking resulted in three times the likelihood that homework was completed. Establishing a contingency between device game time and homework completion resulted in four times the likelihood that homework was completed. Qualitative results suggested that children valued carrying the device and children were

motivated by having game time on the device as a reward. In addition, qualitative results showed that parents valued the device as a contingent reward, desired novelty in the device's games and features, and expressed an urgent need for help with their children's organizational skills.

Children will utilize a mobile technology intended for task tracking with game time having a high reward value. Parents value the concept of using a mobile technology to improve their children's organizational skills. The use of mobile technology for building and sustaining organizational skills via performance rewards is a promising intervention for effective home and school-related task management. The effectiveness of a more fully developed mobile technology needs to be assessed in future research.

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# CHAPTER 1

## INTRODUCTION

Two of the most common neurodevelopmental problems of childhood are attention-deficit/hyperactivity (ADHD) and autism spectrum disorder (ASD). The core symptoms of ADHD include hyperactivity, impulsivity, and inattention. During childhood, ADHD leads to impairments in behavioral, emotional, educational, and social functioning (Barkley, Fischer, Smallish, & Fletcher, 2006). The term ASD is used to describe the continuum-based neurobiological disorder characterized by impairments in social communication and interaction; and restricted, repetitive, patterns of behavior, interests and activities (American Psychiatric Association, 2013; Caronna, Milunsky, & Tager-Flusberg, 2008).

ADHD and ASD often co-occur with symptoms that create challenges in multiple life domains (Sinzig, Walter, & Doepfner, 2009). Research for this dissertation focused on the development and testing of an intervention for organizational skills deficits—a problem common to children with ADHD and ASD. Organizational skills deficits include difficulties with managing materials, and difficulties with temporal aspects of organization such as planning and managing tasks to completion (Langberg, Epstein, & Graham, 2008a).

This chapter begins with an overview of ADHD and ASD. This is followed by a review of research on comorbidity and etiological commonalities between the disorders. Current research suggests that ADHD and ASD have commonalities in executive function (EF) deficits. The concept of EF is reviewed, as deficits in this area likely lead to difficulties with organizational skills. This chapter concludes with a description of the purpose and significance of this research for social work and an overview of the following chapters.

## Attention-Deficit/Hyperactivity Disorder (ADHD)

ADHD, a neurodevelopmental disorder, may be subdivided by the core symptoms of hyperactivity/impulsivity, and inattention. The *Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5)* allows for three possible ADHD presentations. Some individuals are primarily hyperactive and impulsive, some are mainly inattentive, and others have both hyperactivity/impulsivity and inattention (American Psychiatric Association, 2013).

A review of worldwide studies of ADHD inferred the best prevalence estimate as 5.3% in children and adolescents and 4.4% in adults (Polanczyk & Rohde, 2007). However, the Centers for Disease Control (CDC) reports that the prevalence of ADHD in children aged 5 to 17 years increased from 6.9% during 1998–2000, to 9.0% during 2007–2009. These data were based on parental reporting of whether or not their children had ever received an ADHD diagnosis. The report suggested that the current higher rate may be attributed to increased awareness of the symptoms and better identification of the disorder (Akinbami, Liu, Pastor, & Reuben, 2011). Using an estimate of 50 million

children between the ages of 6 and 17 years in the United States (Federal Interagency Forum on Child and Family Statistics, 2013) results in a total of 2.6 (5.3%) to 4.5 (9.6%) million children who are diagnosable with ADHD.

Along with the core symptoms, the typical functional difficulties related to ADHD during childhood include conflicts with parents, teachers, and peers, and poor academic performance. At home, children with ADHD often act without thinking, have difficulty stopping rewarding activities and starting challenging tasks, are noncompliant with rules and directions, have conflicts with siblings, are forgetful and disorganized, and may be loud and intrusive (Salmeron, 2009).

At school, children with ADHD have difficulty completing seatwork assignments, poor peer relationships, and frequent conflicts over behavioral expectations with teachers. Although often intellectually capable, children with ADHD struggle to complete assignments accurately, finish work within expected timeframes, and complete and return homework (Barkley et al., 2006).

A meta-analysis of 72 studies covering effect sizes for 181 outcomes found that individuals with ADHD have significantly lower levels of school achievement relative to controls, with a difference of Cohen's $d = .71$, a fairly large effect size. Variables related to achievement included in this meta-analysis were grade point average, parent and teacher ratings, failing a grade, class rank, dropping out of school, and receiving special education (Frazier, Youngstrom, Glutting, & Watkins, 2007).

The probability of superiority (*PS*) method of interpreting this effect size (Cohen's $d = .71$) suggests that 70% of the time a randomly selected student without ADHD will have higher achievement scores than a randomly selected student with

ADHD. The *PS* method for interpreting effect sizes is used throughout this dissertation (Durlak, 2009; Fritz, Morris, & Richler, 2012).

Once thought to persist only until adolescence, the core symptoms and associated impairments related to ADHD have been shown by research to carry on into adulthood (Wilens, Biederman, & Spencer, 2002). The long-term risks associated with ADHD include poor educational achievement, underemployment, substance abuse, legal troubles, relationship failures, and a variety of other negative life outcomes (Brassett-Harknett & Butler, 2007).

Empirically supported interventions for ADHD include medication, parent and teacher mediated behavioral treatments, and self-regulation strategies (Barkley, 2002; Trout, Ortiz Lienemann, Reid, & Epstein, 2007). For more than 40 years a number of alternative and scientifically unproven treatments have been tried for ADHD. These include dietary changes, nutritional supplements, sensory integration training, anti-motion sickness medication, treatment for lead toxicity, and Candida yeast infection therapy (Goldstein, 2000).

In recent years, neurofeedback has shown some promise for improving cognitive self-regulation and perhaps for reducing core behavioral symptoms (Roman, 2010). However, based on a limited number of high-quality studies, highly divergent dependent variables, and a wide range of effect sizes reported, neurofeedback continues to be considered a scientifically unproven treatment (Toplak, Connors, Shuster, Knezevic, & Parks, 2008).

Psychostimulant Medications

Psychostimulant medication helps to reduce the core symptoms of ADHD in approximately 70% of children. The general effect size related to reduction of hyperactivity/impulsivity and inattention as a result of treatment with psychostimulant medication is estimated at Cohen's $d = 1.0$, a large effect size (Daughton & Kratochvil, 2009; Faraone, 2009; Faraone & Buitelaar, 2010). Interpreting this effect size using the *PS* method suggests that 76% of the time a randomly selected child from a medication treatment group will have a better response on target symptoms than a randomly selected child from a control group.

However, in terms of symptom reduction, up to 30% of children do not respond well to medication (Hazell, 2009; Jensen et al., 2001). In addition, medication may not help with long-term academic performance (Parens & Johnston, 2009). Furthermore, studies have shown that parents, teachers, and children rate behavioral treatment as more acceptable than medication (Johnston, Hommersen, & Seipp, 2008; Krain, Kendall, & Power, 2005).

Behavioral Interventions

Treatment of ADHD has often included psychosocial interventions as well as medication. With regard to psychosocial interventions, behavioral treatments have the greatest empirical support. Behavioral treatments include child-focused behavior modification, behavioral parent training, teacher-mediated classroom contingency management, and self-regulation strategies (Barkley, 2002).

Several systematic reviews and meta-analytic studies have demonstrated the effectiveness of behavioral interventions for ADHD (DuPaul & Eckert, 1997; Jadad et al., 1999; Van der Oord, Prins, Oosterlaan, & Emmelkamp, 2008). Most recently, Fabiano and associates (2009) conducted a meta-analysis that included 174 studies and 2,094 participants. The dependent variables included parent report of decreased problem behavior, teacher report of improved classroom behavior, and observation of changes in child behavior. The 20 between group studies (523 participants) included in the meta-analysis by Fabiano and associates (2009) showed an average effect size of Cohen's $d$ = .83. The *PS* for this effect size suggests that 72% of the time a randomly selected member of a behavioral treatment intervention will show greater improvement on target symptoms than a randomly selected member of a comparison group.

Overall, there is strong empirical support for the efficacy of a range of child-only and parent/teacher-mediated behavioral interventions for children with ADHD as well as children with other behavioral problems (Corcoran & Dattalo, 2006; DuPaul & Eckert, 1997; Fabiano et al., 2009; Lundahl, Risser, & Lovejoy, 2006).

Self-Regulation Interventions

In addition to behavioral interventions mediated by parents and teachers, research has demonstrated the positive effect of a variety of self-regulation interventions for ADHD. A meta-analysis of 16 studies with 51 participants of self-regulation interventions, including self-monitoring, self-monitoring plus reinforcement, self-management, and self-reinforcement, with children from 8 to 12 years of age demonstrated that self-regulation interventions, in particular self-assessment and self-

recording, can produce meaningful improvements in classroom performance (Reid, Trout, & Schwartz, 2005).

The overall effect size found for self-regulation interventions in increasing on-task behavior, decreasing inappropriate behavior, and improving academic accuracy and performance was greater than Cohen's $d = 1.0$ (Reid et al., 2005). When interpreted using *PS*, this effect size suggests that 76% of the time a randomly drawn child who received a self-regulation intervention will have greater improvement on measured outcomes than a child who did not receive the intervention. Although self-regulation interventions have empirical support, the evidence is not as strong as with parent- and teacher-mediated behavioral treatment and medication, as most self-regulation studies are single-subject designs with a small number of participants.

## Key Issues with Behavioral Interventions

Two key issues have been emphasized related to behavioral intervention for children with ADHD. First, children with ADHD need rewards and consequences given at the *point of performance* (Barkley, 2007). When rewards or consequences are delayed, behavior is not likely to change. In an article describing methods for assisting children with ADHD in school settings, Fowler (2010) calls ADHD a point of performance (POP) problem that requires POP interventions. Whether for the purpose of strengthening positive behavior or reducing problem behavior, children with ADHD respond best when rewards and consequences occur immediately following desired or undesired behaviors.

Although immediate rewards or consequences are a hallmark of effective behavioral interventions in general (Kearney, 2007), they often are delayed in practice.

Many children with behavioral problems respond to delayed consequences (e.g., a problem in the classroom in the morning results in no afternoon recess). However, children with ADHD do not think ahead and anticipate rewards and consequences. They typically do not self-regulate behavior in the present based on future rewards or consequences. This may be related to the core symptoms of impulsivity and inattention or to executive function deficits in planning and working memory (Wåhlstedt, Thorell, & Bohlin, 2009; Willcutt, Doyle, Nigg, Faraone, & Pennington, 2005).

Second, children with ADHD need ongoing behavioral intervention in order to maintain gains. Sustaining behavioral treatments in an ongoing manner was described by Barkley (2010) as providing a *motivationally prosthetic* environment. The concept of designing environments to provide sustained reinforcement was originally described as providing a *behavioral prosthesis* by Lindsley (1973) more than 40 years ago. When structure (antecedent management) and contingency management interventions are withdrawn, the problem behaviors of children with ADHD often drift back toward pre-treatment levels.

This drift toward baseline functioning occurs even when studies have planned for maintenance of treatment gains (Barkley, 1997). This lack of maintainenance of gains may be related to factors such as whether or not children fully learn new behaviors, whether the focus of the intervention was relevant, and whether adequate planning for sustaining change occurred. However, the lack of maintenance of gains is more likely a problem grounded in the neurodevelopmental nature of the disorder (Abikoff, 2009).

Historically, behavioral intervention efforts were directed at reducing the core symptoms of hyperactivity/impulsivity and inattention, and eliminating related problems.

The mindset was that interventions could be designed to reduce or eliminate problems and create long-term change. However, ADHD is currently viewed as a neurodevelopmental disorder with consequent long-term impairments that require sustained interventions.

Therefore, a short-term model for intervention is unrealistic for the long-term developmental deficits related to ADHD (Barkley, 2011a). Although the findings have been challenged, a recent meta-analytic study concluded that no nonpharmacological treatments have demonstrated a large and lasting effect on reducing the core ADHD symptoms (Sonuga-Barke et al., 2013). As a result of the dominance of the short-term symptom reduction intervention paradigm, and the lack of better outcomes, Barkley (2007) concluded that there have been no major innovations in psychosocial treatments for ADHD in the last 20 years.

## Autism Spectrum Disorder (ASD)

ASD is a neurodevelopmental disorder characterized by impairments in social communication and social interaction; and restricted, repetitive patterns of behavior, interests, or activities. ASD is evident in childhood and ranges in severity from mild to severe impairment (American Pyschiatric Association, 2013).

A review of 45 years of research estimated the prevalence of ASD in children as 0.7% (Saracino, Noseworthy, Steiman, Reisinger, & Fombonne, 2010). A study based on parent reporting found rates of 1.1% for children aged 3 to 17 years (Kogan et al., 2009). Most recently, the Centers for Disease Control's Autism and Developmental Disabilities Monitoring (ADDM) network published an epidemiological report based on 11 U.S. sites that showed a prevalence of 1 in 68 (1.47%) in children age 8 years (Centers for Disease

Control, 2014). With an estimated 50 million children between the ages of 6 and 17 years in the United States (Federal Interagency Forum on Child and Family Statistics, 2013), a 1.47% estimate for ASD results in 735,000 children.

High-functioning autism spectrum disorder (HFASD) is the term used to describe ASD in which symptoms are mild to moderate and a child has average or above intelligence (typically IQ > 85) (Corbett, Constantine, Hendren, Rocke, & Ozonoff, 2009; Lopata et al., 2012; Volker, 2012). HFASD has been estimated as occurring in 56% of children having ASD (Carpenter, Soorya, & Halpern, 2009). Using this rate of occurrence relative to overall ASD leads to an estimate of 420,000 between the ages of 6 and 17 with HFASD in the United States (Federal Interagency Forum on Child and Family Statistics, 2013).

Because the current study focuses on children with high-functioning autism spectrum disorder, the abbreviation HFASD is used when reviewed literature is specific to this group and when referring to the participants in this study. The abbreviation ASD is used when reviewed literature focuses on the overall autism continuum.

Children with HFASD display the core ASD symptoms with wide variation along a continuum. In general children with HFASD often do not accurately read social cues, may be physically or verbally intrusive, and have difficulty with communication. They may speak with an unusual pace, tone, or cadence (Carpenter et al., 2009). They often become fixated on narrow topics or interests. They often lack the ability to engage in age-appropriate reciprocal play. In addition, they often adhere to rigid and inflexible routines (Carpenter et al., 2009; Nicholas et al., 2008).

In adulthood, the majority of individuals with HFASD experience unemployment and underemployment, lack independence in activities of daily living, and are unmarried and lack romantic or sexual relationships (Howlin, 2000). However, in a more recent review, Howlin (2007) concluded that the outcomes are improving for individuals with HFASD in the areas of education and employment. These improved outcomes may be explained by better identification of individuals with HFASD who have higher levels of function and intelligence, or by improved intervention programs and ongoing support (Carpenter et al., 2009).

Psychosocial Interventions for HFASD

The typical psychosocial interventions for HFASD are focused on remediating social communication and interaction skills deficits. This includes interventions such as learning effective communication skills, developing peer relationships, and engaging in appropriate school behavior. In addition, interventions often focus on reducing problematic behaviors, such as adhering to rigid and inflexible actions or routines, noncompliance, inattentiveness, anxiety related behaviors, isolation, and hyperactivity/impulsivity (Carpenter et al., 2009).

School settings use a variety of psychosocial interventions for HFASD including social skills training, inclusion with higher functioning peers, speech and language therapy, peer-mediated social skills development, academic accommodations, self-regulation strategies, and behavioral interventions (Hess, Morrier, Heflin, & Ivey, 2008). In the last few years several social skills programs have been developed and tested in randomized clinical trials (Gantman, Kapp, Orenski, & Laugeson, 2012; Lerner &

Mikami, 2012; Thomeer et al., 2012). However, overall there are few well-developed psychosocial interventions available for children with HFASD (Carpenter, et al., 2009).

## Comorbidity and Executive Function

Prior to 1990, ADHD and ASD were typically viewed as separate and distinct psychiatric disorders. By the mid-1990s, researchers increasingly conceptualized the disorders as primarily neurodevelopmental in origin and began to study their similarities (Barkley, 1997; Ozonoff & Jensen, 1999; Russell, 1997). Currently ADHD and ASD are often viewed as co-occurring, with neurodevelopmental similarities, and perhaps some shared genetic and neurobiological underpinnings (Rommelse, Franke, Geurts, Hartman, & Buitelaar, 2010; Ronald, Simonoff, Kuntsi, Asherson, & Plomin, 2008; Soorya & Halpern, 2009).

### Comorbidity

Numerous studies have demonstrated comorbidity between ASD and ADHD using assessment and diagnostic measures. However, the rate of comorbidity reported varies greatly. Studies have reported a range from as low as 2% to as high as 78%. For example, in a recent study of 1,838 children and adolescents with ASD, only 16% were found to meet clinically significant levels of ADHD according to parent reporting. When teacher ratings were included, this dropped to 2% (Hanson et al., 2013).

In contrast, Sinzig and colleagues (2009) evaluated the level and type of ADHD in a group of 83 children with ASD. Forty-three (53%) met the full *Diagnostic and Statistical Manual of Mental Disorders, 4th Edition, Text Revision (DSM-IV-TR)* (American Psychiatric Association, 2000) criteria for ADHD. Of these children, 46% met the criteria

for inattentive type, 32% met the criteria for combined type, and 22% met the criteria for the hyperactive/impulsive type of ADHD.

Controversy continues as to the best estimate of comorbidity. The varied rates of overlap may be a result of the methods and measures used to ascertain each disorder. For instance, if an instrument or method casts a wide net for ASD rates of ADHD may also be higher (Hanson et al., 2013). The concept of each disorder containing some symptoms creating the appearance of the other, described as *epiphenomena* by Sinzig and colleagues (2009), provides another explanation for the varied rates of comorbidity. In conclusion, although the rates of overlap continue to be debated, there is compelling evidence for co-occurrence of symptoms between the disorders (Frazier et al., 2001).

Executive Function

In addition to comorbidity between the disorders, there are neurodevelopmental similarities between ADHD and ASD. These neurodevelopmental similarities are conceptualized as EF deficits. EF is a broad term referring to mental processes that lead to physical, emotional, and cognitive self-control (Corbett et al., 2009). The term EF is used in two ways in the literature: (a) as an overarching theoretical construct to describe mental processes leading to self-regulation of goal-directed behavior, and (b) as a general term to describe various abilities (behavioral or neuropsychological) considered essential for generating purposive and goal-directed actions (Brown, 2006).

The most well-known EF theory related to ADHD is Barkley's (2011a) *self-regulation* theory. In this theory, the core symptoms and associated difficulties such as organizing, initiating, and inhibiting behavior stem from neurodevelopmental impairment in self-regulation, which is the core EF. Following this theory, point of performance

behavioral contingencies are needed to promote self-regulation. Accordingly, self-regulation may progress developmentally through the provision of a motivationally prosthetic environment (Barkley, 2011a).

In contrast, the neuropsychological and behavioral assessment approach to EF involves breaking down the core concept into constituent measurable constructs. The neuropsychological measurement approach is not without criticism, as more than 68 EF constructs have been described and measured (Barkley, 2011b; Packwood, Hodgetts, & Tremblay, 2011). The typical EF abilities of children with ADHD and ASD measured through neuropsychological tests include working memory, cognitive flexibility, planning, fluency, vigilance, and response inhibition (Corbett et al., 2009; Geurts, Verté, Oosterlaan, Roeyers, & Sergeant, 2004; Ozonoff, 1997; Ozonoff & Jensen, 1999).

Neuropsychological measures show varied EF commonalities and differences between ADHD and HFASD. However, planning is one area in which neuropsychological research has shown little difference between the disorders (Corbett et al., 2009). In addition to results from neuropsychological tests, parent and teacher rated EF assessments show deficits in planning, organization, working memory, initiating, and emotional control for children with ADHD and HFASD (Semrud-Clikeman, Walkowiak, Wilkinson, & Butcher, 2010).

## Organizational Skills

Whether viewed as functional deficits related to the core symptoms, as the result of comorbidity, or as the consequences of common EF deficits, children with ADHD and HFASD have organizational skills deficits in areas such as planning, initiating, and

managing tasks to completion. Langberg and associates (2008a) described organizational skills as including two dimensions: (a) materials management such as organizing homework, school materials, and other items, and (b) temporal aspects such as planning, tracking, and scheduling.

With ADHD, the *DSM-5 inattention* category includes symptoms that are essentially organizational skills deficits. These symptoms include difficulty organizing tasks and activities; losing things and forgetfulness; and failure to finish schoolwork, chores, or duties in the workplace (American Pyschiatric Association, 2013). For many years the inattention symptoms were not conceptualized as organizational skills deficits. In recent years the shift to focus on organizational skills deficits has led scholars to describe the core symptoms as hyperactivity/impulsivity and *inattention/disorganization,* thereby emphasizing that *disorganization* is a prominent theme in the inattention symptoms (Miller, 2012).

Research focused on directly measuring organizational skills has demonstrated that children with ADHD have deficits when compared to nonADHD children. Abikoff and Gallagher (2008) described children with ADHD as having deficits in organization, time management, and planning (OTMP). The Children's Organizational Skills Scales (COSS) were developed by Abikoff and Gallagher (2009) to measure deficits based on the OTMP model. Research using the COSS has demonstrated that children with ADHD have deficits in organized actions, task planning, and memory and materials management as compared to children without ADHD (Abikoff & Gallagher, 2009).

There is a relatively small, but excellent body of research focused on psychosocial interventions for improving organizational skills for children with ADHD. This

intervention literature is reviewed in Chapter 2. In addition to psychosocial interventions, research has shown that medication improves organization through the reduction of hyperactivity and inattention; however, it does not eliminate the difficulties children with ADHD have with organizational skills (Abikoff et al., 2009).

In contrast to ADHD, there is very little research related to organizational skills deficits and interventions for children with HFASD. However, difficulties with organization in children with HFASD may be viewed as a consequence of comorbidity with ADHD and/or related to the symptom cluster of restricted, repetitive patterns behaviors such as inflexible adherence to routines or difficulties with transitions (Hartley & Sikora, 2009).

Importantly, a study of EF impairment in children with HFASD using neuropsychological measures concluded that "organizational deficits are the most compelling from this study because they were consistently documented across multiple verbal and visual tasks" (Kenworthy et al., 2005, p. 822). Furthermore, in a comprehensive review of HFASD, Carpenter and colleagues (2009) listed organizational skills as an area in which additional research and intervention development were needed.

## Statement of the Problem

Children with ADHD and HFASD have organizational skills deficits that lead to poor materials management and difficulty with the temporal organizing, planning, and task management. These children frequently have disorganized desks and rooms, lose personal items, are not ready for school, fail to follow directions, and do not complete

chores and tasks. The result at school is poor academic performance, with consequent conflict with parents and teachers.

Although organizational skills interventions have demonstrated promising results (e.g., Abikoff et al., 2013; Langberg et al., 2013), there is an ongoing need for further development and research in this area. Without the development of more effective and sustained organizational skills interventions children with ADHD and HFASD will continue to be hampered by disorganization, conflict with parents and teachers, and poor school performance. These difficulties may lead to long-term problems such as oppositional behaviors, academic underachievement, underemployment, conduct problems, relational problems, and overall diminished life opportunities.

## Purpose of the Study

The purpose of this study was to conduct a formative usability test of a prototype mobile technology designed to be an organizational skills intervention for children with ADHD and HFASD. Mobile technology may be defined as any handheld or portable device that includes wireless Internet connectivity. Mobile technology includes the device itself (hardware), the software application (interface), and the communication medium (wireless networks) (Jarvenpaa & Lang, 2005).

This study evaluated the prototype for usability. The International Standard for Organization, abbreviated ISO, provided a standard definition with usability defined as, "the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use" (International Organization for Standardization, [ISO], 9241:11, 1998). Because the definitions of

usability are varied with some scholars listing as many as ten or more constituent constructs (Abran et al., 2003), the basic ISO (9241:11, 1998) definition was used as the grounding elucidation for the purposes of this study.

The concepts of effectiveness, efficiency and satisfaction from the ISO (9241:11, 1998) may be further elaborated with effectiveness meaning the accuracy and completeness that a product brings to goal achievement; efficiency as the resources such as time, amount of use, and mental effort needed to achieve desired goals; and satisfaction defined as the users positive feelings, attitudes and perceptions of a product or system (Frøkjær, Hertzum, & Hornbæk, 2000). Scholars have debated what constructs best constitute usability, whether or it is helpful to have a standard definition, the extent to which usability is context dependent, and how best to operationalize the construct for more than 20 years (e.g., Hertzum & Clemmense, 2012; Hornbaek, 2006; Seffah, Donyaee, Kline, & Padda, 2006; Quesenbery, 2003; Neilsen, 1994).

In practice, usability testing occurs through both summative and formative tests. Summative tests are completed after an application is developed. Historically, they were often grounded in traditional experimental research methods. Goals of summative usability tests include demonstrating the general effectiveness of a product, or the superiority of a product as compared to other products or earlier versions. Summative tests typically rely on quantitative data gathered from large samples, and often use inferential statistics to evaluate outcomes (Rubin & Chisnell, 2008; Scholtz, 2004).

Andrews (2009) pointed out that with the current emphasis on rapid development and user centered design in software engineering, summative tests are becoming a relic of the past. Most current testing is formative. Formative tests are completed earlier, and

often are repeated throughout product development in order to evaluate and guide ongoing design. Formative tests utilize both quantitative and qualitative data collection methods and take a more flexible approach to research design and validity as the primary goal of formative testing is to facilitate further product design versus demonstrate general product effectiveness or infer causation (Farrelly, 2009; Hornbæk, 2006).

Additional aspects of formative usability testing often include gaining feedback on proposed product features and assessing a product for proof of concept. Proof of concept (POC) may be defined as the demonstration of the feasibility of some method or product idea for further development through the use of a prototype or early design (Pentakalos, 2008). Feasibility is a determination as to whether a product is appropriate for further development and testing (Bowen et al., 2009).

In summary the purpose of this study was to conduct a formative usability test of a prototype mobile technology designed to improve the organizational skills of children with ADHD an HFASD. The purpose included evaluating the extent to which the product was usable, features for further design, and proof of concept for the feasibility of future development.

## Significance for Social Work

As a profession, social work is concerned with alleviating human suffering, enhancing human wellbeing, and providing resources to underserved and marginalized groups (National Association of Social Workers, Code of Ethics, 2008). Children with ADHD and HFASD represent underserved and marginalized populations. Social workers often work with children with ADHD and HFASD as well as their families at home, in

school, and in a variety of community settings. Social workers need to increase their knowledge and skills related to children with ADHD and ASD, topics that are insufficiently covered in social work education (Berzin & O'Connor, 2010).

When fully developed the proposed device and application will serve as a digital assistive technology. Digital assistive technology has been used with disabled and disadvantaged populations to improve functioning and quality of life (Anttila, Samuelsson, Salminen, & Brandt, 2012; Sze, 2008). Mobile technology applications continue to be developed to assist children and youth with disabilities such as ASD, hearing impairment, and a variety of learning disabilities (retrieved from: http://www.emergingedtech.com/category/special-needs-students). Furthermore, digital technologies hold the potential for economically marginalized youth to access education, exercise creativity, build social capital through participation, and develop collaboration skills (Hourcade, Bullock-Rest, and Schelhowe, 2010). Significantly, building digital technology interventions to serve disabled and disadvantaged populations are consistent with social work research, advocacy and practice.

The current study integrated social work research methods with usability testing concepts and methods. Parker-Oliver and Demiris (2006) called for the development of a field of social work informatics with social workers participating in the design, development, and use of digital technologies. This study represents an initial effort to integrate social work research with digital technology design and development.

## Summary

Chapter 2 of this dissertation reviews research related to organizational skills interventions for children with ADHD and HFASD. Chapter 3 describes how the current study is situated in social work, human factors, and design research. Design research is described, followed by a description of the proposed fully developed mobile technology. The connection between social work and design research is described by reviewing the social work design and development research model. The design-based field of human factors and the subfield of child computer interaction are reviewed as providing a background to usability testing with children. The chapter concludes with a description of the connection between usability testing and social work research. Chapter 4 describes the methods used in the usability test. This includes a description of the setting, the study participants, the prototype, sources for data collection, and approach for data analysis. Chapter 5 presents the results of the study. Chapter 6 provides a discussion of the research questions related to usability and feasibility of the technology, and describes the potential for social work to engage in a greater role in research, policy, and practice related to technology development.

# CHAPTER 2

# ORGANIZATIONAL SKILLS INTERVENTIONS

This chapter reviews the literature on ADHD and HFASD with a focus on intervention research related to organizational skills. The chapter begins with a description of the impact of organizational skills deficits in school settings. This is followed by a review of organizational skills research related to ADHD and HFASD. Mobile technology is being developed to support skill acquisition for children with ASD. The emerging research in this area is reviewed. The chapter concludes with a description of the potential for mobile technology to be used as a long-term assistive technology to improve the organizational skills and functional outcomes for children with ADHD and HFASD.

## Organizational Skills in the School Setting

Difficulties with organizational skills impact children with ADHD and HFASD at home and at school. However, school-related organizational skills deficits are more apparent and consequential, as there is a high demand for organizational skills in educational settings (Dorminy, Luscre, & Gast, 2009; DuPaul & Kern, 2011; Langberg et al., 2008a). For example, homework completion is a very complicated task. The homework completion cycle is a multiplayer task that requires student organizational

skills combined with parent and teacher support and monitoring. Children with learning disabilities, ADHD and ASD have a broad range of challenges related to homework completion as a result of language, attention, motivation, memory and organizational skills deficits (Bryan, Burstein, & Bryan, 2001; Power, Werba, Watkins, Angelucci, & Eiraldi, 2006).

Throughout the homework completion cycle, children with ADHD and HFASD lose items, forget to record homework assignments, fail to take needed school materials home, fail to complete assignments accurately, forget to return assignments, do not complete assignments with distant due dates, and seldom keep materials organized (Dorminy et al., 2009; DuPaul, Weyandt, & Janusis, 2011; Raggi & Chronis, 2006). Parents and teachers give frequent prompts, correction, and behavioral penalties for homework-related problems. In addition, teachers and parents often develop a bias toward children with ADHD and HFASD, labeling organizational skills deficits as noncompliance or failure to take responsibility.

Organizational skills interventions for homework and school have focused on teaching strategies and skills for self-management, along with providing positive reinforcement to enhance compliance. For example, children may be given planners and taught to record assignments, organize materials, complete task lists, and track due dates. Children then receive points or privileges from parents or teachers for following a method or protocol (Abikoff et al., 2013; Langberg et al., 2008a). Intervention programs have been designed specifically to improve homework completion for children with ADHD and HFASD. In addition, these programs have included focusing on reducing

parent-child conflict and improving home-school colloboration (Clarke et al., 2013; Korzekwa, 2011; Power et al., 2012).

The desired long-term functional outcomes include increased rates of homework completion, improved parent-child relationships, and higher academic performance. Importantly, in many of the organizational skills intervention studies that follow the rate of homework completion is often a key dependent variable. The proposed technology is intended to assist with homework completion and other tasks at home and at school. The following section provides a brief review of the laws related to assistive technology use in school settings.

Education and Mobile Assistive Technology

The Technology-Related Assistance for Individuals with Disabilities Act (Public Law No. 100-407) was passed in 1988. It brought attention to the role assistive technology can play in improving the functional needs of people with disabilities (Alper & Raharinirina, 2006). The Act was revised in 1994 and 1998. The 1998 revision, The Assistive Technology Act (Pub. L. No. 105-394), defined an *assistive technology device* as "any item, piece of equipment, or product system, whether acquired commercially, modified, or customized, that is used to increase, maintain, or improve functional capabilities of individuals with disabilities" (p. 112). This revision emphasizes that individuals with disabilities have the right to access and use assistive technology in education, work, and the community.

The Individuals with Disabilities Education Act (IDEA) of 1997 mandates that the assistive technology needs of all students with disabilities be considered as part of the

Individualized Education Plan (IEP) development process. Finally, the Assistive Technology Act of 2004 (Pub. L. No. 108-364) amended the term *assistive technology service* to include "a service consisting of expanding the availability of access to technology, including electronic and information technology to individuals with disabilities" (p. 1155). Based on this legislation, schools are required to use a digital assistive technology device if it will potentially benefit a child with a disability.

The digital mobile technology tested in this study is designed to assist children with ADHD and HFASD with organizational skills. The following sections review intervention research designed to improve organizational skills in these populations. This research provides a background for the present study as it confirms features of the technology, suggests additional areas for consideration, and helps to identify limitations with current interventions that may be addressed through the development of a mobile technology.

## Organizational Skills Intervention Research and ADHD

One comprehensive review of organizational skills intervention research relates to children with ADHD. Langberg and colleagues (2008a) divided research into organizational skills-only interventions and multicomponent approaches, which included additional intervention areas such as peer relationships, noncompliance, and overall family conflict. The approach followed by Langberg and associates (2008a) is helpful as it differentiates studies with clear organizational skills interventions from those with less clearly defined interventions.

The literature review for the current study included research on organizational skills interventions with a clear inclusion criterion of children with ADHD as participants and interventions specifically focused on organizational skill development. The search strategy used was to start with the Langberg and associates (2008a) review, then search for earlier omitted articles, and then search for those published from 2008 to the present. Most organizational skills intervention studies have used single-subject designs and were published within the last decade. The intervention strategies, dependent variables, findings, limitations of research to date, and areas for further research associated with those studies are included in this review. Table 1 presents an overview of the studies focusing specifically on organizational skills interventions.

## Single-Subject Designs

Currie, Lee, and Scheeler (2005) used personal digital assistants (PDAs) to assist homework tracking with four students with ADHD aged 12 to 14 years. This single-subject design included a 6-week baseline period during which students were taught to enter assignments in a planner and teachers checked compliance with planner use and homework completion. After the 6 weeks, participants were given PDAs and taught how to use these to follow a similar procedure for entering and tracking homework. During the ensuing 11-week intervention period, teachers followed the same process of prompting, randomly checking student compliance with use of the PDAs, and monitoring homework completion.

Table 1 Organizational Skills Intervention Studies for ADHD

| Study | Intervention | Dependent Variables | Key Findings |
|---|---|---|---|
| Currie, Lee, & Scheeler (2005) | Self-managed PDA for homework tracking | Rate of homework return | Increased homework completion<br>Acceptability of technology |
| Gureasko-Moore, DuPaul, & White (2006) (2007) | Self-managed checklists for preparedness and homework completion | Student completion of preparation checklist<br>Student completion of homework | Increased preparedness and homework completion<br>Parent, teacher, student acceptability<br>Self-management effective |
| Langberg, Epstein, Urbanowicz, Simon, & Graham (2008b) | Notebooks and method of organization, and positive reinforcement | Student gains in org. skills<br>Ratings of homework probs.<br>Academic gains | Gains in grade point average<br>Positive reinforcement helps<br>Parents, teachers, and student inclusion needed |
| Abikoff & Gallagher (2008) | 20-session pilot program to improve organizational skills | Change on COSS<br>Parent ratings of homework improvement | Improved organization skills<br>Better homework ratings<br>Parent, teacher satisfaction |
| Langberg et al. (2011a) | 11-week homework, school materials, planning intervention with reinforcement | Change on COSS<br>Homework problems<br>Changes in grades | Small changes in grades<br>Parent acceptability<br>More parent/teacher involvement needed<br>Rewards need to be more frequent and varied |
| Abikoff et al. (2013) | (1) 20-session organizational skills training (10 weeks)<br>(2) Performance-based intervention | Parent/teacher-rated COSS<br>Parent conflict<br>Grade point average | Skills training effective<br>Performance-based intervention effective<br>Reduced parent/teacher conflict<br>Academic improvement |

*Note.* COSS = Children's Organizational Skills Scales; PDA = personal digital assistant.

During the 6-week baseline period, the average rate of homework completion ranged from 26% to 63% for the four students. During the intervention phase when PDAs were used, three of the students had homework completion rates between 86% and 90%. The fourth student had a mean completion rate of 26%. Overall, the students felt the PDAs were useful for organizing assignments and improving homework completion. In addition, the students liked using the PDAs and said they were easy to use, thus supporting acceptability. Teacher responses were mixed, however, as they agreed that the PDAs were helpful with organization and homework completion, but disagreed that the PDAs helped improve quality of work (Currie et al., 2005).

The changes in rate of homework completion with the PDAs as compared with use of a paper planner may have been related to the novelty and game-like nature of the device. Research has shown that children with ADHD respond to novelty: It adds color, animation, and movement all of which capture interest and attention (Zentall, 2005). In addition, changes in homework completion rates may have been related to status associated with possession of the PDAs or to an assumed contingency between using the device as planned and having continued access to it. The authors concluded that digital technology was promising for helping children with ADHD. Limitations of this study included a small number of participants, lack of long-term follow-up, failure to assess quality of homework, cost of the PDAs, and mixed interest from teachers (Currie et al., 2005).

Two single-subject design studies (Gureasko-Moore, DuPaul, & White, 2006; Gureasko-Moore, DuPaul, & White, 2007) focused on using self-managed checklists for classroom preparedness and homework completion. The authors chose self-management

interventions because they require students to take initiative with managing their actions, require less teacher time, and hold the potential to generalize across settings (Gureasko-Moore et al., 2006).

In these two studies, middle school students in general education settings were taught to use checklists to self-manage classroom preparedness and homework completion. In addition, teachers completed a classroom preparation checklist to verify changes in preparedness, and parents completed a homework completion checklist to verify homework completion. The intervention period in these two single-subject multiple baseline designs lasted an average of 6 weeks.

During the baseline periods, classroom preparedness was demonstrated typically by less than 50% of the participants, and parent reported homework completion rates ranged from 18% to 66%. After the interventions, all students regularly demonstrated classroom preparedness behaviors, and students completed homework nearly 100% of the time. Teachers, students, and parents rated the interventions as useful and effective, thus supporting acceptability (Gureasko-Moore et al., 2006; Gureasko-Moore et al., 2007).

Limitations of the these two studies include possible confounding of the self-management strategies with social reinforcement from teachers, minimal participant diversity, exclusion of children with comorbid diagnoses, limited generalizability of single-subject designs, limited follow-up periods, and failure to include changes in grades as an outcome measure (Gureasko-Moore et al., 2006; Gureasko-Moore et al., 2007). However, these studies lend support for the effectiveness of children's self-management of organizational skills strategies.

Within Group Designs

Abikoff and Gallagher (2008) designed a 10-week, 20-session pilot program to improve the organization of materials, time management, and planning skills of 20 children in Grades 3 to 5 who were diagnosed with ADHD. The program included a variety of modules focused on improving organizational skills using various elements of cognitive behavioral therapy. It included skill training, modeling, practice, cueing, self-monitoring, and contingency management by teachers and parents.

Along with pre–post measures of effectiveness, the pilot study focused on feasibility and acceptability of the intervention by children, parents, and teachers. The children made improvements, as measured by parent and teacher ratings of improvement on the Children's Organizational Skills Scales (COSS). Both parents and teachers were satisfied with the skills training intervention. Along with pilot data showing effectiveness based on the COSS, this study demonstrates the social acceptability of an organizational skills intervention to teachers, parents, and students. Because this was a pilot study, percentages of improvement and effect sizes were not reported.

Langberg and colleagues (2011a) conducted a study with 11 middle school students to test and refine the Homework, Organization, and Planning Skills (HOPS) intervention. This study represents a further extension of the HOPS program (Langberg et al., 2008a) that assists adolescents with skills in homework management, materials management, and planning. The 11-week 16-session program was delivered by school-based mental health staff and represented an attempt to deliver an organizational skills intervention program in a natural setting. Participants received instruction in skills such as organizing a book bag and locker, using a planner for recording assignments, and

establishing an evening time to complete homework. A positive reinforcement system was included in which participants earned gift cards for successfully using the organizational method.

Quantitative and qualitative data were gathered to assess the program. The quantitative parent report data indicated large gains (Cohen's $d$ = 1.8) in organizational skills as measured by the COSS, and large reductions in homework problems (Cohen's $d$ = 1.6). Although the effect sizes are large, without a comparison group there may be many factors beyond the intervention that led to the outcomes. Teacher ratings showed no improvements on the COSS. Parents rated the program as positive on a number of items related to satisfaction.

The main themes derived from the focus groups with school mental health staff and teachers included: (a) the material was delivered too fast; (b) rewards were highly motivating but delayed too long and more flexibility was needed; (c) teachers needed to be more involved; (d) an unobtrusive method was needed for verifying accurate recording of assignments in the planner; (e) a tracking system was needed for monitoring missing assignments; (f) additional parent involvement was needed; and (g) methods were needed to increase student ownership of the intervention.

The study supports the potential effectiveness of a planning and materials management organizational skills intervention that includes student self-management, parent and teacher involvement, and positive reinforcement. The authors noted that the focus groups and collaborative approach to intervention development provided valuable feedback regarding feasibility and functionality of the program. Limitations included the lack of a control group, limited generalizability, and the lack of long-term followup. The

authors concluded that the program may be difficult to deliver on a large scale and that additional research and interventions focused on organizational skills were needed (Langberg et al., 2011a).

Between Group Designs

Langberg and associates (2008b) further tested the HOPS intervention for improving organization of materials and homework management. The specific components of the intervention consisted of a book bag and binder for organization, a planner for accurate assignment recording, and a method for long-term assignment planning. The 8-week (two sessions per week) afterschool program included 37 children in Grades 4 to 7 randomly assigned to the intervention ($n = 24$) or to a wait-list control group ($n = 13$). The difference in size of group was based on a request from the school for the maximum number of children to receive the intervention when the study started.

A treatment manual was developed that included methods for organization and homework management. A contingency management system reinforced participant use of the notebook and the organizational method. In some cases, teachers verified use of the planner by initialing entries. During the afterschool program, participants earned free time minutes and points for gift cards for successfully using the organizational method. The intervention included two parent meetings, with the goal of transferring performance monitoring and contingency management responsibilities to parents.

Students in the intervention group improved their organization of materials after treatment, and these gains continued through follow-up. At the baseline measurement, students in the intervention group were recording assignments and future exams in their

planners 30% of the time. During the final 2 weeks of the study, intervention group students were recording assignments and exams 72% of the time. In contrast, wait-list control participants were recording assignments 21% of the time.

The standardized mean difference between the groups on parent ratings of the Homework Problems Checklist (Anesko, Schoiock, Ramirez, & Levine, 1987) was Cohen's $d = .71$ (Langberg et al., 2008b). The *PS* for this effect size suggests that 69% of the time a randomly selected member of the treatment group would have a higher score than a randomly selected wait-list control group member. Teachers rated the academic performance of the intervention group slightly above that of the wait-list, and small gains were also shown in grade point average for the intervention group.

This strength of this study was an experimental design with random group assignment and a well defined intervention. The limitations of this study included the lack of well differentiated ADHD diagnoses, the lack of parent and teacher follow-up data, the lack of parent and teacher blinding to group assignment, and difficulty differentiating the effects of the organizational skills intervention from those of the behavioral rewards. The authors concluded that, although the results were positive, future research was needed to focus on the long-term effects of organizational skills interventions, in particular on improvements in actual grades (Langberg et al., 2008b). The findings of this study support the positive effect of materials management and planning skills interventions combined with consistent positive reinforcement.

Finally, a two-site, randomized clinical trial (RCT) compared two programs to assist with organization, time management, and planning. A key question examined in the study was whether organizational skills would be better improved primarily through

skills training or through contingent rewards (performance based). The issue of whether ADHD related problems are grounded in a lack of skills, or an inability to do what one knows (performance deficit), has constituted a long-standing debate in the literature (Barkley 1997; Greene & Ablon, 2001).

The study included 158 children in Grades 3 to 5 who had been assigned to an organizational skills training (OST) condition, a performance based intervention, or a wait-list control group. The organizational skills intervention was a further development of Abikoff's (2008) pilot program. The comparison intervention (the performance based program) used daily report cards (DRCs) to monitor performance, with parents and teachers rewarding children for successful task completion. The primary outcome measure for all conditions was the parent and teacher rated COSS; however, a number of other outcomes, such as academic performance and parent-child conflict, were also included.

The OST intervention showed an effect size of Cohen's $d = 2.77$ on the parent rated COSS and Cohen's $d = 1.18$ on the teacher rated COSS as compared to the wait-list control group. The *PS* for Cohen's $d = 2.77$ and Cohen's $d = 1.18$ suggest that a randomly selected member of the OST group would have a 97% (for parent rating) and 80% (for teacher rating) chance of having a better score on the COSS than a randomly selected member of the wait-list control group. The performance based program was also effective. Although the OST program showed a slight improvement on parent rated COSS (Cohen's $d = 0.63$) over the performance based program, on most outcome measures the programs were equally effective.

Importantly, the OST intervention positive effect extended beyond organizational skills to include improvements in the children's academic performance and reduced conflict with parent and teachers. At the end of the study, 60% of the children in the organizational skills and performance based interventions were in the nonclinical range on the COSS, whereas only 3% of the wait-list control group children were in the nonclinical range (Abikoff et al., 2013).

The study found that skills training and performance based interventions were equally effective. The authors concluded that future interventions may provide the greatest benefit if they focus on both organizational skills and performance based rewards. The children in the study were followed for 1 year. Although there was some drift toward baseline as measured by the COSS, most of the treatment gains were maintained. The researchers attributed this maintenance to the specific focus of the intervention (e.g., organizational skills) versus a more broad based intervention (e.g., social skills).

One limitation of the study was that parents and teachers served as both raters and treatment providers, thus introducing the potential for bias. Other limitations were that the families were of relatively high socioeconomic status, they were above average intelligence, and their ratings of acceptability were not included. In addition, the rate of oppositional behavior was less than typical, and the group had an overall higher than usual number of children with ADHD inattentive type (Abikoff et al., 2013).

Conclusion for ADHD Studies

In conclusion, research has demonstrated that interventions focused on materials management, planning, and task management improve organization and homework completion, and may impact grades. In addition, organizational skills interventions are acceptable to parents, teachers, and children. An examination of these studies shows that the core intervention components integrated by the researchers included a clear method of materials management and temporal organization, child self-management, and contingency management by teachers or parents. Limitations of these organizational skills-specific intervention studies include the lack of comparison and control groups, short follow-up periods, lack of assessing the impact of the intervention on actual grades, and small numbers of participants.

## Organizational Skills Intervention Research and ASD

Soorya and Halpern (2009) concluded that the absence of published studies focused directly on organizational skills interventions with HFASD makes this as an intriguing area for future research. Following an extensive literature search, six research articles related to organizational skills interventions with HFASD were discovered. The databases Academic Search Premier, PsycINFO, Medline, and ERIC were searched using the terms *autism*, *high-functioning autism*, *Asperger's*, and *pervasive developmental disorder* in varying combinations with the terms *organizational skills*, *time management*, and *planning*.

These studies, none of which involve group comparisons, include single-subject designs, single-case reports, and descriptive research. Based on descriptions of the

participants, these studies were focused on individuals with HFASD. None of the studies included assessment or diagnosis of an ASD as part of the study method. Table 2 provides a summary of these organizational skills studies for children with HFASD.

Case Studies

Stromer, Kimball, Kinney, and Taylor (2006) described several case studies using PowerPoint slide presentation software to design visual schedules for children with autism. For example, a pictorial schedule of activities was developed to help a 6-year-old girl understand the content of activities and make transitions. The pictorial schedules were transitioned to a notebook schedule and eventually to a text-only schedule because she was an avid reader. Overall, the case studies reported in this article support the use of creating visual schedules using technology.

Limitations of the study included that it only provided descriptive case reports, with only one of these reports specifically focused on organizational skills. In addition an excessive amount of time and effort were needed to generate visual schedules using the PowerPoint slide presentation approach.

A case study in occupational therapy described how a PDA was used to help an adolescent boy with Asperger syndrome increase accuracy in recording homework assignments (Smith Myles, Ferguson, & Hagiwara, 2007). The baseline for entry and accuracy of homework in the boy's planner was 34%. The goal of the intervention was for the participant to accurately record the subject, the due date, and details of assignments. The student was given a PDA and learned to use it in one 20-minute training session. After he learned to use the PDA, the student was told he would earn up to four points for accuracy of entries for three subject areas. During the intervention

Table 2 Organizational Skills Intervention Studies for ASD

| Study | Intervention | Dependent Variables | Key Findings |
|---|---|---|---|
| Bryan & Gast (2000) | Picture albums for tasks and schedule | On-task behavior<br>On-schedule behavior | Improved independent on-task and on-schedule behavior<br>Students liked the method<br>Visual prompts recommended |
| Stromer, Kimball, Kinney, & Taylor (2006) | Pictorial schedule using PowerPoint | Understanding of activity content<br>Making activity transitions | Children liked the method<br>Generalized to notebook and text only<br>Technology promising for pictorial schedules |
| Smith Myles, Ferguson, & Hagiwara (2007) | PDA for entering homework assignments | Accuracy of entering homework, including due date | Improved rates of accuracy<br>Desirability of PDA<br>Novelty of the PDA<br>PDA unobtrusive in the school setting |
| Cahill (2008) | Self-regulated learning of an organizational method | Improved accuracy in recording assignments | Improved independent recording and accuracy<br>Self-regulation strategy as empowering |
| Dorminy et al. (2009) | Folders for organizing and self-monitoring for accuracy | Improved accuracy of filing and retrieval | Improved accuracy of filing<br>Parent report of decreased missing homework<br>Method translatable to home and school settings |
| Gentry, Wallace, Kvarfordt, & Lynch (2010) | PDAs for task management | Use of PDAs<br>Acceptability | Consistent use of PDAs<br>PDAs occasionally lost<br>Used beyond original goal<br>Valued by participants |

*Note.* PDA = personal digital assistant.

period, his rate of accurate entry was 61%. Overall, his independent recording of homework increased by 29%. The authors concluded that easing handwriting demands, the novelty of the PDA, and motivation to use it, were likely factors leading to the increase in homework completion. The PDA was viewed as an unobtrusive device that shows promise for improving student organization (Smith Myles et al., 2007).

A second case study in occupational therapy (Cahill, 2008) used self-regulated learning of organizational methods for a student with Asperger syndrome who was transitioning to junior high. The 13-year-old boy had never learned to record assignments. A set of procedures using self-observation, self-reaction, self-evaluation, and self-reinforcement components was developed for the student to organize, monitor, and reinforce schoolwork completion. After the intervention, the student increased his independent recording and completion of homework. A specific percentage increase was not reported.

Single-Subject Designs

Bryan and Gast (2000) taught four boys aged 7 to 8 years and diagnosed with autism, to use picture activity schedules to improve on-task and on-schedule behavior. The intervention was evaluated in a single subject A-B-A-B design. Prior to the intervention, the participants' on-schedule behavior was rated as occurring between 4% and 21% of the time. During and after utilization of the picture book, all of the boys were on schedule between 45% and 100% of the time. The authors concluded that the students learned the method quickly, they maintained high levels of independent on-task and on-schedule behavior, and the method decreased a variety of negative off task behaviors.

The students liked the method and wanted to continue to use their picture books. Suggestions for future research included using visual prompting systems to help children with HFASD improve on-task and on-schedule behavior (Bryan & Gast, 2000).

A single subject, multiple baseline study with four elementary students diagnosed with HFASD (Dorminy et al., 2009) involved developing folders and teaching students to organize academic materials and self-monitor for accuracy. The dependent variables in this study were the percentage of correctly filed items and the time it took students to retrieve items. During the baseline period, students filed school materials accurately 45% to 75% of the time. During the intervention period, the students filed items accurately 70% to 100% of the time, with a percentage of nonoverlapping data (PND) of 100% for the intervention period. The times for retrieval were not reported. Teachers were satisfied with the procedure, and parents reported less missing homework. The authors noted that a simple visual organization system plus self-monitoring eliminated the need for adult assistance in organizing school materials. Developing organizational skills methods and using self monitoring were recommended as interventions likely to be beneficial in both school and home settings (Dorminy et al., 2009).

In another occupational therapy based study, 22 high school students with ASD were trained to use PDAs as tools for task management (Gentry, Wallace, Kvarfordt, & Lynch, 2010). Participants identified forgetting appointments, difficulty remembering to complete chores, problems with homework management, and forgetting medication as areas in which they needed help. Eight weeks after training in the use of the PDAs, 82% of the participants were using the calendar and alarm functions independently for scheduling; however, the level of use varied among the participants.

Although the study was not designed specifically for the school setting, 10 students reported using the PDAs for recording homework assignments, remembering medications, and setting other appointment reminders during school. Three participants tried to bring their PDAs to school, but school regulations did not allow this. The authors concluded that the PDAs were considered socially acceptable by the participants and appeared to improve task completion. Sixteen of the participants reported occasionally losing their PDAs and typically finding them after their alarms sounded. The final recommendations of this study emphasized the need for further research on developing ecologically valid digital assistive technologies. The use of digital technology for children and youth with autism was described as a field in its infancy (Gentry et al., 2010).

### Conclusion for HFASD Studies

In conclusion, there are few organizational skills specific studies focused on individuals with HFASD, but the published studies often include the same intervention elements that have been used and found effective for children with ADHD. These intervention elements include methods for materials management, methods for task planning and monitoring, self management strategies, and parent or teacher monitoring and reinforcement. A final and important similarity is the emphasis on using digital technology to enhance acceptability of organizational skills interventions.

## ASD and Mobile Technology

There is an emerging body of research that reports on the development of digital technology for children with ASD. For example, Hayes and colleagues (2010) developed

two prototype digital technologies: (a) Mocotos, a prototype mobile technology assistive communication device, and (b) vSked, an interactive classroom visual scheduling system for children with autism. vSked included behavioral rewards given by teachers when children followed a schedule. Both of these technologies, in early stages of development, were designed and evaluated through observation of children and focus groups.

Mintz, Branch, March, and Lerman (2012) reported the initial results of a large multiuniversity European project called HANDS (Helping Autism-diagnosed teenagers Navigate and Develop Socially), which focuses on designing a mobile technology application to assist youth with ASD to develop life and social skills. The software involves a complex intuitive visual prompting system for teaching and assisting children to successfully make choices and navigate their social worlds.

The HANDS program allows teachers to partner with children to assist with life skills. When children use a social or life skill appropriately, they receive immediate individualized rewards, such as a favorite cartoon character on a smartphone or time to watch a favorite movie. The mobile application has been pilot tested in four schools in Denmark, Sweden, Hungary, and the United Kingdom (retrieved from http://hands-project.eu/).

The research methods for gathering initial data on outcomes of HANDS included student observation, semistructured interviews, and questionnaires. From the initial qualitative data analysis of the HANDS project, two key recommendations for developing mobile technology for children with ASD emerged. First, it was recommended that the technology link home and school. Second, the study recommended using technology that children find appealing and to which they become attached.

Finally, the report concluded with the suggestion that similar design guidelines and mobile technology could be used with other groups, such as children with ADHD (Mintz et al., 2012).

## Implications for the Design of a Mobile Technology

Children with ADHD and HFASD have deficits in materials management and temporal aspects of organization. Research on organizational skills interventions for children with ADHD and HFASD has focused on skills training, materials management, self-management, and parent and teacher contingency management. Although numerous organizational skills interventions have shown positive effects, there is an ongoing need to design interventions that further integrate the promising elements of previous interventions and use technology to meet the needs of children with ADHD and HFASD.

Digital devices such as PDAs have been used to automate temporal aspects of organization, such as scheduling and task management. Children with ADHD and HFASD have responded positively to the use of technology for temporal organization (Currie et al., 2005; Gentry et al., 2010; Smith Myles et al., 2007). Importantly, emerging research is focused on developing and testing mobile technology to assist children with ASD and/or ADHD, and their families, in various life domains (Chen et al., 2012; Lufi, Bucherman, Akita, Cohen, & Sibani, 2012; Mintz et al., 2012; Rahimabadi, Moghadamnejhad, & Fomani, 2013).

Along with direct contingencies and support for children, mobile technology offers the ability to create a network of real time communication where parents and teachers may serve as partners to offer children feedback and support. Communication

via mobile technology offers the potential to strengthen home–school collaboration (Cox, 2005; Patton, Jayanthi, & Polloway, 2001; Polloway, Bursuck, & Epstein, 2001).

The present study focused on evaluating a prototype and informing the design of a mobile technology to enhance organization, planning, and task management that comprise the temporal aspects of organization for children with ADHD and HFASD. The proposed fully developed mobile technology is intended to support children in self-management of tasks and activities by providing point of performance (POP) rewards. In addition, the proposed technology includes a method for home–school communication and positive reinforcement for successful task completion. Finally, the fully developed application is intended to serve as a long-term motivational prosthesis to sustain gains.

Chapter 3 describes how the present study integrated concepts from design, human factors, child computer interaction, usability testing, social work design and development research.

# CHAPTER 3

# DESIGN AND SOCIAL WORK RESEARCH

This chapter reviews and integrates literature related to the concepts of design, social work design and development (D&D) research, human factors including the subfield of child computer interaction, and usability testing. A brief review establishing the context of design research is followed by a description of the proposed fully developed mobile technology modeled by the prototype in the present study. This is followed with a description of the social work D&D research paradigm. The fields of human factors, human computer interaction, and the emerging field of child computer interaction are described as they provide a background for usability testing of digital technology. The concepts of user centered design and typical approaches to usability testing are reviewed. The chapter concludes with a description of the compatibility between social work research and usability testing.

## Design Research

At the broadest level, this research was grounded in design. Design may be described as the activities that generate a product from a need, idea, or technology. These activities include documenting needs, creating and testing initial products or solutions, and developing an end product that satisfies the needs of stakeholders and customers.

Design affects every aspect of life and each design situation is unique, including those involving modifications to current products (Blessing & Chakrabarti, 2009). The terms innovation, design, and product development are often used interchangeably. *Innovation* is often used as a conceptual term for creativity in the social sciences; *design* is typically used more to describe engineering; and *product development* is used more globally to describe the entire process of innovation, engineering, and design. Both quantitative and qualitative methods are used in design research (Marxt & Hacklin, 2005).

Design research is intended to generate knowledge in building and improving a product to meet a need. While traditional research in the social sciences is focused on understanding and knowledge building, design research is focused on understanding *and* creating or improving a product (Chakrabarti, 2010). Hevner (2010) differentiated a *design-science paradigm* focused on creating new and innovative artifacts from a *behavioral-science paradigm* focused on verifying theories that explain or predict human behavior. Thomas (1978) emphasized this same difference in relationship to designing social work interventions.

Design research focuses on the entire process of moving from a creative idea through the practical process of developing and evaluating a product or solution. The desired outcome of the research is to inform or validate the real world actualization of a technology. This difference between traditional social science and design research is important, as it impacts the relative emphasis on the articulation of a foundational theoretical framework, the selection of methods, the processes of data collection, the methods of data analysis, and the desired outcome of study findings. Typical desired

outcomes for design research include assessing the need for a product, testing an initial design, and gathering data to inform further product development (Chakrabarti, 2010).

Design research methods require a merging of social science research skills with elements of technical design processes (Blessing & Chakrabarti, 2009). Social science knowledge and research skills are needed to understand human behavior. Technical skills are needed to create technology that fits with complex human behavior needs. In describing a recent course developed on design research, Chakrabarti (2010) pointed out that there was limited material available to guide a new researcher in this area. Blessing and Chakrabarti (2009) provided a list of numerous historical models to describe design research, but emphasized that there is a lack of common overarching theoretical frameworks and corresponding methods for design research.

There is an increasing call for the funding of design research, as it is the first step in innovation. Acknowledging the need for this emerging field, universities have developed centers for design intended to sponsor innovation and gain financial support for design research. A report sponsored by the Kauffman Foundation (Gulbranson & Audretsch, 2008) called for funding for proof of concept centers at universities. The report emphasized that there is lack of funding for product design, yet the outcome of developing an innovative product or solution extends from improving a human condition to creating economic growth. Consistent with this call, the present study involved initial design research, with a long-term goal of improving the lives of children with ADHD and HFASD.

Proposed Mobile Technology Reference and Impact Models

Innovation and design are grounded in the idea that the limitations of a current technology can be resolved or improved upon by developing a new product. Blessing and Chakrabarti (2009) described the current condition as the *reference model* and the new creative idea as the *impact model*. As part of the design process, they stressed the importance of defining the limitations of the current reference model as well as the improvements intended for the impact model. A brief description of the current organizational skills problems, limitations, and consequences for a typical child with ADHD or HFASD are described in the following section (the reference model). This will be followed by a description of the vision for a fully developed assistive technology (the impact model).

Reference Model: School Experience for a Child with ADHD or HFASD.

Emma, a fourth-grade student with ADHD, writes down her spelling assignment in her assignment book, but forgets to record the workbook page number or the due date, which is 2 days later. She simply writes "spelling." Emma takes her workbook and planner home. She takes everything out of her backpack. She becomes curious about the last pages showing the national holidays at the back of the planner. She carries it to the family room, turns on the television, and leaves the planner with a stack of magazines on the coffee table. She watches television and soon forgets about her homework and the planner. Her mother asks her if she has homework. She remembers spelling and goes and gets her workbook. She can't remember the page and can't find her planner, so she goes to her bedroom and completes the page she thinks is the right one.

Two days later, Emma gathers her backpack as she leaves for school; she didn't have her planner yesterday, and she still can't find it. She takes her spelling workbook to school, but when she completed the spelling assignment she tore it out of the workbook and left it on her bedside table. By now it is has fallen on the floor and has been kicked under the bed. Emma receives a zero for the assignment when she says she could not find it. Her teacher tells her she needs to use her planner, be more organized, and learn to be responsible for her schoolwork.

Over time, Emma's mother becomes increasingly frustrated because Emma, who is very bright, gets zeroes on homework, can never remember what she needs to do, can't find things, and seldom turns in assignments. Emma becomes resentful toward her mother and teacher for constantly telling her she needs to work harder to be responsible. After several weeks, her grade report arrives. Emma is failing spelling. Her mother remembers to check the school's website. Emma has received a 90 or above on every spelling exam; however, she is missing six out of 12 assignments.

## The Impact Model: The Fully Developed Mobile Technology

The handheld mobile technology tested in this study was designed to help children with ADHD and HFASD improve organization, planning, and task management. Along with child self-management of organization, the application is designed to facilitate communication between parent, child, and teacher. The device is intended to be a digital motivational prosthesis for improving organization. The fully developed technology will incorporate the use of antecedent prompts, self monitoring, POP rewards, parent/teacher monitoring, and positive reinforcement.

The technology will be designed around a calendar system for tracking activities and tasks. It includes a point earning system in which rewards are given at the POP for successful task entry and completion. For instance, when a student enters an assignment correctly, a teacher may verify it on a similar handheld device. Whether the assignment is entered correctly or not by the student, the correct assignment will immediately be sent to both student and parent. The child will earn points for entering the assignment and additional points for accurate recording of details of the assignment.

Points earned for successful organization, planning, and task management will be converted to minutes for electronic games or music on the mobile device. The device also may serve as the exclusive controller for other devices, such as a computer, television, and videogame system. Points are customized in the system according to the student's schedule and needs. The software is Web-based, with a parent setup and management site. Parents have access to their child's calendar, a customizable task list, daily school information, point values and associated minutes, and rewards. Key features of the fully developed mobile technology will include:

- A daily schedule that prompts the child for tasks to be completed at home and/or at school. For school, this will include assignment entry by class with details, due dates, and materials needed.
- Time based prompts for follow-through and completion. Prompts may be set to display automatically at any time, such as near the end of a class or at the end of the school day. This feature will provide the basic functions of a daily school assignment book and task log.

- Animated visual rewards and points awarded at the POP for student homework or task entry, accuracy, and completion. Points will be banked, but not secured, until they are validated through the Internet by a teacher and/or parent.
- Parent access to a task list that is shared with their child through the application website. Automatic texts to parents when tasks/assignments are entered by their child or successfully completed (e.g., homework logged by a teacher at school).
- Conversion to minutes for game time on the device only for points validated by parents. Parents may create other nondevice related point value activities and use their mobile device to manage points and minutes of device time used.
- Child self-monitoring of tasks and school assignments, with immediate POP rewards, such as animations, points, and potential game minutes, for completion of tasks.
- Capability of turning off all features of the mobile device other than the task management system and emergency calling during school through a website.

In addition, since the application will be integrated with school learning management systems, it will require minimal additional teacher time. Finally, the Internet database will be designed to continually collect data to assist with further application development and will make information on feedback/trends available for parents, teachers, and children.

Impact Model: School with an Assistive Mobile Technology

Emma carries her mobile device attached to her waist. The device vibrates to give her a prompt to enter her assignment near the end of the language arts period at school. Her teacher writes the assignment on the board. Emma enters the assignment, and the

application prompts her to include page numbers, due dates, and extra information and features a drop down list for checking off any necessary supplies. When she completes the entry and presses the save button, an animated graphic appears and she is rewarded with points for entering the assignment and accurately matching her teacher's learning management system entry.

Near the end of the school day, Emma receives another vibration prompt to remember assignments. Emma takes home her spelling workbook and other supplies necessary to complete her homework. The calendar feature of the application helps her track assignments over time. Emma and her mother have negotiated that she may access game time after she has completed her evening homework. Because Emma has all the details and supplies on hand, she is able to complete her homework and show it to her mother, who can then verify her points for game time on the device.

In the morning, the device alarm sounds, and Emma receives a reminder to take her homework back to school. After she turns in her homework, her teacher electronically verifies that her homework has been returned and an automatic text is sent to Emma's mother. Emma receives immediate points for turning in her homework. Emma is motivated to earn points, gain approval from her parent, earn game time, and earn minutes for all of her digital devices.

Emma's mother is appreciative that she knows when Emma's homework is turned in instead of occasionally hearing from her teacher or periodically checking the school Website, only to find out that multiple assignments are missing. Emma's mother and teacher, who now have more positive interactions with Emma, comment that she is doing a great job completing her homework.

## Social Work Design and Development Research

From the late 1970s to the mid-1990s, social work scholars were constructing a model for intervention development that mirrored the steps and processes of design research. The term *developmental research and utilization* (DR&U) was first used to describe this effort to map the logical process of designing social work interventions (Thomas, 1978). This work created a conceptual model for the design process that included five phases—analysis, design, development, evaluation, and dissemination (Rothman & Thomas, 1994; Thomas, 1989). The DR&U research model was created with the intent that more effective social work interventions would result if the process of development was clearly conceptualized and intervention design was viewed as a process of systematic inquiry.

Interest in DR&U arose out of increasing recognition of the inadequacies of existing research methodologies for designing new social work interventions. Thomas (1978) noted that in fields such as engineering or computer sciences, new technology development was driven by more systematic methods than in the social sciences. He suggested that social technology was often developed in a haphazard and unsystematic manner. A less systematic approach to development may suffice when a proposed intervention is centered broadly in human relationships and interactions. However, the present study focused on technology development in which a more systematic approach is needed.

Thomas (1978) pointed out that DR&U research was difficult for social workers to grasp at first, because they traditionally used the methods of behavioral science research. He described the behavioral science model as focused on theory testing and

knowledge building. In contrast, he described developmental research as the social version of developing a new product. Although the behavioral science model of research and the developmental research model share similarities, the behavioral science model has limitations for generating new social technology. The starting points (early design versus late stage evaluation) and desired outcomes (knowledge building versus practical information for informing future design) differ between developmental research and traditional social science research (Thomas, 1978).

The actual realization of a new intervention was viewed as the central feature and desired outcome of the DR&U model. Emphasizing that real world actualization in social work ought to be consistent with other fields, Thomas (1978) advised including (a) the development of a prototype if the desired intervention product was a device, (b) clear protocols if the goal was remedying a specific problem, and (c) an overarching theory and model for more broad based social service programs.

From the standpoint of DR&U, social work may be viewed as a field with ongoing technological advancement similar to medicine or engineering. The products or practices of social work are *social technologie*s intended to create change from micro to macro levels. Thomas (1978) listed nine types of social work technology. Two technologies relevant to the present study are electromechanical devices and information systems. Interestingly, 35 years ago, Thomas (1978) noted that the rapid advance of computer technology tended to drive development in all types of social technology.

The final articulation of the social technology model, called *design and development (D&D)* research by Rothman and Thomas (1994), included the phases of problem analysis and project planning, information gathering and synthesis, program

design, early development and pilot testing, evaluation and advanced development, and dissemination.

The goal of D&D was to create a model that covered the entire span of developing socio-technological interventions. The problem analysis phase of the model involved identifying a problematic human condition and gathering information related to the problem. This problem stage included gathering information from reviews of literature, as well as a variety of other sources, such as field research and needs assessment. The next phase of the model, information gathering and synthesis, involved analyzing relevant data, innovation, and ultimately resulted in the initial design of a new product or social technology.

In the D&D model, pilot testing occurs early and evaluation is ongoing as social technology is created and refined. Thomas (1978) noted that typical social science evaluation often becomes an end in itself. In the D&D research paradigm, evaluation is viewed as an integral step toward further product revision, design, and development. A broad range of behavioral science research methods, both quantitative and qualitative, may be utilized to assess the product in terms of effectiveness, efficiency, cost, and benefit. This evaluation, in turn, may result in further innovation, redesign, trial use, and evaluation until a successful or useful social technology is developed (Thomas, 1978). Once a social technology is demonstrated to be effective, the goal is to work toward refinement and broad based dissemination.

Unfortunately, the D&D research model was largely abandoned by the field of social work. Over the years, there has been minimal model testing and only a few case studies or exemplars of its use in the literature. Bailey-Dempsey and Reid (1996) applied

the model to the development of a school based case management program. In addition, there is one recent article in which the D&D model was used to structure the process of creating an intervention to address sibling aggression (Caspi, 2008). The authors of these studies concluded that although the model was helpful, there is often a lack of funding for design, and the early steps in the process may be taken without systematic inquiry or reporting.

The strengths of the D&D model in terms of articulating a systematic process of design are helpful when social work encounters technology development. The present study follows portions of the first five steps of the D&D model as follows: (a) the study started with problem analysis and project planning, (b) the literature review involved information gathering and synthesis, (c) the prototype was designed based on research and clinical knowledge, and (d) the study involved exploratory (pilot) usability testing and evaluation. The testing process included evaluating the interface between human behavior and an electromechanical device. From a social work standpoint, the D&D model provided a theoretical framework for this research.

In summary, the D&D model appears to be linear with successive stages and steps. In contrast, the actual design process is much more fluid, cyclical, and iterative. The D&D model serves better as a heuristic method rather than as a lock-step sequential process to be followed. The nonlinear, creative, and iterative approach to design and development is a hallmark of current approaches to software engineering (Cao & Ramesh, 2008).

## From Human Factors to Child Computer Interaction

Software engineering processes have been highly influenced by the field of human factors. Human factors is the historic discipline focused on evaluating and designing the fit between humans and mechanical devices. Human factors, human factors engineering, and ergonomics are the terms used to describe the scientific discipline of studying human abilities and limitations and applying this knowledge to the design of systems to maximize safety, performance, and satisfaction. These terms are often considered as equivalents, with *human factors* used in the United States and *ergonomics* used in Europe; however, the term ergonomics is becoming more commonly used around the world.

Although the development of human factors as a discipline may be traced back to the turn of the 20th century, scholars often describe the efforts of Elias Porter and the design of aircraft cockpits in World War II as a key marker in the development of the field. This period marked a turn from expecting humans to fit machines, to engineering machines to fit humans (Shaver & Braun, 2009).

Following World War II, the human factors discipline became an increasingly standard aspect of product development. It merged the social and psychological aspects of human behavior with the technical aspects of design, and early human factors specialists were either psychologists or engineers. The human factors field grew in the military and aviation fields with the founding of the Human Factors and Ergonomics Society (HFES) in 1957 (Shaver & Braun, 2009).

The creation of the personal computer further facilitated development of the field of human factors. The term *human computer interaction* (HCI) describes the subfield of

studying the relationships between human abilities and computer technology. The formal development of HCI, linked to the first conference on human factors in computing held in 1982, also involved a blending of ideas from multiple streams of knowledge, such as computer science, psychology, engineering, and human factors (Meister & Enderwick, 2002).

There are a number of organizations that continue to represent the fields of human factors and HCI. These include the HFES and the Association for Computing Machinery (ACM). ACM publishes a number of journals related to HCI and holds an annual conference each year called Special Interest Group on Computer-Human Interaction (SIGCHI), at which innovative thinking and research in HCI is presented (Shaver & Braun, 2009; Zhang, Carey, Te'eni, & Tremaine, 2005).

Within the last 10 years, a special interest group within SIGCHI has been formed to focus on child computer interaction (CCI) and interactive design for children. Interactive design for children is a broader field that studies child factors in relationship to overall product design, but is not specifically focused on computers. CCI incorporates the traditional knowledge and activities of HCI within the context of child psychology, learning, and play. CCI is now considered a unique field of study within the broader fields of human factors and HCI. It focuses on the unique qualities, needs, and abilities of children as they participate in the development of technology and interact with it. There is an emerging body of literature describing theoretical frameworks and presenting case studies that offer guidelines for CCI (Druin, 2002; Froehlich, 2007; Markopoulos & Bekker, 2003). Read and colleagues (Read, Hourcade, Markopoulos, & Druin, 2011) recently promoted CCI as a discipline in its own right, with emerging theory, knowledge,

and methods. Ideas from CCI are included in the description of usability testing at the close of this chapter.

Boff (2006) described the current generation of human factors and ergonomics research and practice as focusing on working with technologies that enhance human capabilities. He suggested that the coming generation of research and practice will focus on enhancement of physical and cognitive capabilities. Consistent with the current focus of human factors on improving physical and cognitive abilities, the present study is an initial examination of the potential impact of an organizational skills technology upon child behavior and functioning.

## Usability Testing

The concept of *user-centered design* that drives current software development grew out of human factors and HCI. User-centered design focuses on the active involvement of end users in product design and development, iterative design based on users' needs, and multidisciplinary efforts throughout the design process (Iivari & Iivari, 2006). Rubin and Chisnell (2008) promoted user-centered design by emphasizing that designers need to understand they are not developing a product per se, but are developing a *relationship* between a human and a product. Therefore, the emphasis of design needs to be focused on users' desires, needs and perceptions versus on a priori assumptions about what will constitute a usable product.

In turn, the concepts of usability and usability testing are related and may be viewed as operationalizing the concept of user-centered design. The term usability developed during the 1980s and since that time it has been variously defined in the

human computer interaction and software engineering literature (Abran, Khelifi, Suryn, & Seffah, 2003; Boehm, 2006; Seffah, Donyaee, Kline, & Padda, 2006). One basic definition of found in a well-known guide to usability testing defines usability as a product doing what a user wants "*the way he or she expects to be able to do it, without hindrance, hesitation, or questions*" (Rubin & Chisnell, 2008, p. 4). The typical definition of usability includes that a product is effective, efficient, and satisfying for end-users to achieve a desired goal (Alshamari & Mayhew, 2009; ISO 9241:11, 1998).

Rubin and Chisnell (2008) expanded their basic definition to include a product being useful, effective, efficient, satisfying, learnable, and accessible. Although numerous models outline the concepts constituting usability, most of the concepts fit within the dimensions of efficiency, effectiveness, and satisfaction. Rubin and Chisnell (2008) pointed out that usability is a hidden, invisible quality existing on a continuum.

*Usability testing* is the term used for the process of working with end-users to evaluate an early design, such as a prototype. The purposes of usability testing are varied. Typical goals include diagnosing problems and validating a designed user experience. This includes the visual, behavioral, emotional, navigational, motivational, and responsive dimensions of user experience (Arnowitz, Arent, & Berger, 2007). The practical purposes may be exploratory, focusing on examining the effectiveness of an initial design, or on information gathering to inform future design (Rubin & Chisnell, 2008).

Usability testing is a form of research that started with summative methods grounded in classical experimental design. However, classical experimental designs are often not practical or feasible for usability testing, in particular with early formative tests

(Rubin & Chisnell, 2008). Formative usability testing usually needs to be done quickly, and it is often impossible to have an adequate sample size or to randomly assign participants to study conditions. Rather than being intended to prove one hypothesis or condition as superior, the results are intended to validate usability and feasibility, and to generate information in order to improve on a design and develop a better product or solution. Formative usability testing typically requires gathering both quantitative and qualitative data, as this integration of multiple data sources may be the best way to inform product design (Bardram, 2008; Rubin & Chisnell, 2008).

A list of the basic elements of usability testing includes (a) generating research questions (versus hypotheses), (b) finding a representative sample of end-users (often not randomly selected), (c) conducting testing in an environment where the product is intended to be used, (d) observing users engaged with the product, (e) interviewing end-users, (f) collecting both quantitative and qualitative data, and (g) creating final recommendations related to furthering product design (Rubin & Chisnell, 2008).

Similarly, Dumas and Redish (1999) described the core features of all formative usability tests as: (a) The main goal is to improve a product, (b) the participants are actual users, (c) the participants do tasks that are actually intended as features of the product. (d) the researcher records what the participants do and say, and (e) data from the test are used to assess the product and recommend changes (Dumas & Redish, 1999).

A broad array of data collection methods is available for usability testing. Martin and Hanington (2012) described 100 ways to research and design effective products. For formative usability testing grounded in user-centered design, a partial list of methods includes ethnography, participatory design, focus groups, observation, surveys, cognitive

walk-throughs, and prototype testing (Martin & Hanington, 2012; Rubin & Chisnell, 2008). Multiple evaluation methods are recommended in conducting usability testing, as this strategy provides the opportunity for triangulation of data from a variety of data sources and perspectives (Arnowitz et al., 2007). Overall, the research methods and data collection techniques used in usability testing are consistent with quantitative and qualitative social work research methods.

An issue related to usability testing addressed in the literature is how many users to include in a test. This question has been evaluated since the 1990s, with no clear conclusion (Bastien, 2010). Nielsen (2006) concluded that 80% or more of interface design problems could be discovered by testing with four or five users and created a mathematical algorithm to demonstrate this. However, the issue continues to be a matter of debate and multiple issues such as time, cost, and availability of participants impact the number of users needed for a test.

In a review of this issue, Bevan et al. (2003) included commentary from a number of information technology scholars. Opinions regarding the number of users to include differed based on the goals and purposes of testing. For instance, testing for validating an initial design may require fewer participants than when working toward advanced development. However, all authors tended to agree that small numbers of participants and multiple tests is the most reasonable method for usability testing.

Testing may occur at any time during the product life cycle. However, there is an increasing view to have end-user involvement as soon as possible in the technology development process (Sullivan, 1989; Sy, 2007). Involving end-users early aligns with the shift in the practice of usability testing to focus first on the behavior, needs, and

activities of the end user, instead of starting with the constraints imposed by technology or early design (Johnson, Salvo, & Zoetewey, 2007). Another more recent change with usability testing is an emphasis on conducting assessments in natural environments described by one scholar as *contextual evaluation* (Wichansky, 2000).

Prototyping

A typical method of testing an application in the natural environment of the end-user is prototyping. A simple and clear definition of a prototype is "a representation of a design, made before a final solution exists" (Moggridge, 2007, p. 26). Prototyping is a method for testing an initial design and for eliciting ideas for future features (Katasonov & Sakkinen, 2006; Kordon, 2002). Prototyping helps to evaluate ideas, uncover design problems, solve problems, and communicate design ideas. Prototypes and initial testing often clarify the complexity of real world concerns and solutions by involving relevant people, places, objects, tasks, and processes in assessing and communicating about a model or concept (Ginsburg, 2011).

There are two main types of prototypes. Throwaway prototypes are developed for the purpose of validating a concept, and eliciting and analyzing requirements. Once the initial test has been completed, further development of the prototype is abandoned. Evolutionary prototypes are designed to be partial versions of a final system. In the evolutionary approach an initial prototype is designed, then modified and refined through ongoing testing, whereby it evolves into the final application (Katasonov & Sakkinen, 2006).

Distinctions are made between fully functioning prototypes and those with limited sets of functions. Very basic models, such as paper prototypes, PowerPoint models, screen designs without functionality, and other designs with limited sets of functions are called low fidelity prototypes. Models with more advanced functions mirroring the actual proposed final design are called high fidelity prototypes (Arnowitz et al., 2007). This distinction is arbitrary as the functionality of prototypes exist on a continuum from low fidelity to high fidelity.

The strength of prototyping is that it takes far less effort to produce a partial model, and then test and make modifications along the path of development, than it does to create a fully functioning application at the outset (Kordon, 2002). In addition, scholars in software design frequently stress the negative consequences of creating and implementing an ineffective product or solution, such as the excessive cost, wasted time, and negative impact (Lyu, 2007).

Prototyping is one of the best ways to assess an early design and thereby avoid an ineffective and unsatisfactory product. The features of a good prototype include simplicity with reasonable functionality, a user interface consistent with the plan for the final system, and the ability to model a set of typical interactions that users will have with the system. In addition, effective prototyping includes rapid development and usability testing in the natural environment of the end user (Katasonov & Sakkinen, 2006).

It has been suggested that prototypes provide the most understandable format for end users when they are asked to evaluate a product design (Campbell et al., 2007). Kordon (2002) asserted that prototyping is the only way to ensure high levels of reliability in design and of success in implementation for critical and complex systems.

Schrage (2004) emphasized the need to create software through ongoing client interaction with prototypes. Usability testing with prototypes leads to greater satisfaction of participants in testing and to better applications when final versions are released (de Sá, Carriço, Duarte, & Reis, 2008).

Children and Usability Testing

Jensen and Skov (2005) reviewed 105 papers on technology design for children and identified the typical research methods used. In this review, the typical purpose of research was evaluation; however, there was a trend toward involving children earlier in the actual designing of products. In more recent studies, children were viewed increasingly as partners in design and studies took place in natural settings. Jensen and Skov (2005) concluded that most research with children involves field studies in natural settings where children readily participate, often more actively than adults. Additionally, natural settings provide the most information for evaluation and engineering of technology for children.

Markopolus et al. (2003) noted the lack of research articles in the literature comparing usability evaluation methods with children. This led to the development of a user evaluation model including such child factors as verbal skills, concentration, motivation, trustworthiness of self reports, ability to adapt to a testing environment, and overall knowledge and skills. The results of a case study showed that children preferred to work with other children, as well as developers, throughout the design process (Markopolus et al., 2003).

McKnight (2010) presented a set of initial guidelines for developing technology for children with ADHD. These guidelines are consistent with current classroom and behavioral management strategies for children with ADHD. McKnight (2010) concluded that designing for children with ADHD requires approaches that represent the best qualities of a user-centered design, such as forming partnerships, engaging users actively, working within the child's frame of reference, and communicating clearly. All of these suggested approaches are consistent with social work practice with children.

## Usability Testing as Social Work Research

Social work D&D research, child computer interaction, and usability testing provide the conceptual foundations for the present research. Social work research has typically focused on knowledge building and outcome evaluation of developed interventions. The present study was completed to inform the design of a mobile technology to assist children with ADHD and HFASD improve organizational skills. Testing the design of the mobile device was a collaborative process among the children, parents, and the researcher. Druin (1999) described the various roles children may play in the design process. Children may be involved as users, testers, informants, and design partners.

In the present study, children served as users and informants as to the usability of an initial prototype. Parents also served as informants related to usability, feasibility, and future product development. This collaboration with parents and children as design partners was consistent with current approaches to usability testing and technology design; and with the *client as partner* value and practice of social work. Chapter 4

provides a detailed description of the method for this formative, mixed methods usability test, starting with a review of the purpose of the study and a listing of the research questions.

# CHAPTER 4

# METHOD

This chapter begins with a review of the purpose of the study, a list of the research questions, and an overview of the study design. This is followed by a description of the setting for the test, human subjects approval, and the sampling procedure. The participants are then described including the method and results of initial screening for ADHD, HFASD, and organizational skills deficits. An overview of the prototype tested is provided followed by a description of the measures and methods for data collection and analysis. The chapter concludes with a description of the procedures by which the test was conducted, and a description of the approach to triangulation.

## Research Questions and Study Design

The purpose of the present study was to conduct a formative usability test of an early prototype of a mobile technology intended to assist children with ADHD and HFASD with organizational skills. The research questions related to usability and features of the mobile technology included the following:

1. Will children with ADHD and HFASD utilize and value a mobile technology designed to assist with organization, planning, and task management, and will utilization improve task completion?

2. Will parents utilize and value a mobile technology designed to assist with organization, planning, and task management?
3. What features of an early prototype do children and parents value, what do they find unappealing, and what features do they want incorporated into a more fully developed mobile technology?

Research Design

The study was designed as a mixed methods field-based usability test. The decision to conduct field testing was consistent with current scholarship which emphasizes that field testing may be more suitable for the complexities of evaluating mobile technology (Coursaris & Kim, 2011; Kallio & Kaikkonen, 2005; Zhang & Adipat, 2005).

Although the ISO standards provide a formal definition of usability that includes efficiency, effectiveness, and satisfaction, in practice, usability is defined as much by context as well as it is by the constructs of effectiveness, efficiency, and satisfaction. In addition, the ISO constructs are not directly measurable (Hornbæk, 2006). Quesenbery (2003) pointed out that in formative testing research questions must move beyond the abstracted ISO concepts and use constructs that fit with the context and objectives for the product that is tested. The research questions for the present study include the constructs utilize, value, and support. These constructs fit with the context and objectives of this study. The final chapter describes the links between the ISO usability constructs of efficiency, effectiveness, and satisfaction; and utilize, value, and support as used in this study.

Consistent with the recommendations of Rubin and Chisnell (2008) both quantitative and qualitative approaches are used to address each research question. In addition, a stated purpose of the study was to evaluate proof of concept for feasibility of the technology for further design. Feasibility is an overarching construct related to usability that is ultimately determined by the overall results of a study and researcher evaluation. Feasibility will be assessed and discussed in the final chapter of this dissertation.

## The Summer Treatment Program Testing Site

The site for the study was Camp Takoda, a summer treatment program (STP) in Salt Lake City for children with ADHD, HFASD, and other related problems, such as noncompliance, conduct problems, and learning disorders. The camp serves children aged 8 to 12 years for a period of 8 weeks each summer.

STPs are grounded in social learning and behavioral theory. The daily program was designed around a structured schedule and a behavioral management system in which children earn points for desirable behaviors and lose points for undesirable behaviors. The daily schedule includes group recreational, educational, and art activities. Each day, children were required to bring backpacks with the following items: swimsuit and towel, ball glove, point card, homework assignment, and lunch. Related to the purposes of the present study, these items provided a clear and concise number of daily materials to manage.

In addition, the STP program included a 90-minute educational period called the academic learning center (ALC). The purpose of the ALC was to assess difficulties

children have with classroom behaviors and strengthen skills needed for successful academic performance. The initial 30-minute ALC class period involved children completing three seatwork assignments. The second 30-minute class period involved peer tutoring by having children read aloud in pairs. The final 30-minute class incorporated the mobile technology for game.

At the end of each ALC seatwork period, children received one simple homework assignment. The assignments were sent home in sealable plastic bags, completed by the children in the evening, and returned the following day. During the following day ALC period a counselor scored homework for completion and accuracy. After the ALC period was finished, the completion and accuracy data were entered into the database for the camp. The purpose was to assess and strengthen the homework completion cycle during the 8 weeks of the summer camp. Additionally, related to the purposes of the present study, the homework assignment process provided a clear temporal and materials management protocol.

## Institutional Review Board Approval

The present study titled "Investigating Usability for ADD.it: A tool for students with ADHD" was initially approved by the University of Utah Institutional Review Board (IRB_00041550) in June 2010 and reapproved in May of 2011. The primary investigator for the study was Jodi Morstein PhD of the College of Nursing. This author served as the coinvestigator for the study for both the 2010 and 2011 approvals.

The primary purpose of the study was described as an effort to gather usability information related to a software application/intervention from observation of student

use, analysis of student feedback, and review of debriefing information from parents. Although the technology was titled ADD.it on the informed consent form, this formal title was not used during the study; therefore, the technology will be described with language that was used throughout the actual study. The parent consent and child assent forms are included in Appendix A (Consent Forms). The process for obtaining consent and assent is described in the procedures section of this chapter.

## Sampling Procedures

Information regarding the STP was sent to elementary schools, posted in pediatric clinics, and listed on a website. Children and parents completed several online assessments and attended an admission screening interview prior to enrolling in the camp. The interview was designed to assess each child for compatibility with the camp. The primary criteria for admission included the child having a history of ADHD and/or HFASD based on parent report, adequate intellectual ability, and no extreme conduct problems. This author and the team leaders for the camp made the admission selections. The children who attended the camp were from middle-to upper-income families. The convenience sample for this usability test included all children enrolled in the camp after parental consent and child assent were obtained. Therefore, the participants included 16 enrolled children and their parents.

## Participants and Screening Assessments

Prior to the start of the summer treatment program, parents of 16 ($N$ = 16) children in grades 3 to 7 ($M$ = 4.5, $SD$ = 1.5) completed an online admission survey that

included demographic data and three standardized assessment instruments. The children, ranging in age from 7 to 13 years ($M = 10.2$, $SD = 1.6$), included 11 boys and 5 girls. Eleven of the children were taking psychotropic medication for the treatment of ADHD and other symptoms such as anxiety, depression, and explosive behavior. Because the focus was on usability testing of an early prototype detailed information related to demographics, child behavioral functioning, specific psychiatric diagnoses, medication, and previous treatment is not reported. The screening instruments are described in the following sections.

Strengths and Difficulties Questionnaire

The Strengths and Difficulties Questionnaire (SDQ) was used to assess the participants' level of hyperactivity/inattention. The SDQ is a behavioral screening questionnaire children aged 3 to 16 years. It is one of the most commonly used screening tools worldwide because it is brief, has well-established norms, and provides extensive data related to reliability and validity (Iizuka et al., 2010). The questionnaire consists of 25 items equally divided across five scales measuring emotional symptoms, conduct problems, hyperactivity/inattention, peer problems, and prosocial behavior. Except for the prosocial scale, the combined scale score reflects total difficulties, indicating the severity of psychosocial problems.

Results from 48 studies ($N = 131,223$) on the reliability and validity of parent and teacher SDQ were summarized quantitatively and descriptively by Stone and colleagues (Stone, Otten, Engels, Vermulst, & Janssens, 2010). Internal consistency scores for the parent rated version for the total difficulties scale was $r = .80$. The subscale internal

consistency scores were $r = .76$ for hyperactivity/inattention, $r = .66$ for emotional symptoms, $r = .58$ for conduct problems, and $r = .53$ for peer problems. SDQ scores remained fairly stable for the duration of 12 months for the total difficulties ($r = .77$) and for impact ($r = .63$). In addition, test–retest correlations were found for hyperactivity and inattention ($r = .77$), prosocial ($r = .64$), conduct ($r = .65$), emotional ($r = .71$), and peer problems ($r = .61$) (Hawes & Dadds, 2004).

Concurrent validity was assessed by comparing the SDQ to the Child Behavior Checklist (CBCL). The SDQ problem scales correlate reasonably well with CBCL subscales that cover similar concepts, such as externalizing, internalizing, social problems, and attention problems. Overall, the SDQ is widely recognized as a useful instrument for screening for ADHD and other psychosocial problems (Stone et al., 2010).

Autism Spectrum Screening Questionnaire

The Autism Spectrum Screening Questionnaire (ASSQ) was designed for school children to identify the likelihood of ASD (Ehlers, Gillberg, & Wing, 1999). It works well as a screening tool when ratings are at or above the 98th percentile. The ASSQ does not diagnose an ASD. It is a screening tool for the probability, or likelihood, of having an ASD. The questionnaire includes 27 items scored on a 3-point scale. The range of scores is from zero to 54, with the higher scores indicating greater endorsement of ASD symptoms (Posserud, Lundervold, & Gillberg, 2009).

Cutoff scores representing high risk for ASD/HFASD were established as greater than 21 points on the teacher version and greater than 18 points on the parent version (Posserud et al., 2009). These scores identified individuals with a high risk of having an

ASD with specificity, also called *true negative rate*, of .90 for parent ratings and .91 for teacher ratings. Sensitivity, described as *true positive rate*, for these cutoff scores was .62 for parent ratings and .70 for teacher ratings (Ehlers et al., 1999; Posserud et al., 2009). The parent rated version of the ASSQ was used as a general screening tool for likelihood of an ASD in the present study.

Children's Organizational Skills Scales

The Children's Organizational Skills Scales (COSS) provide a comprehensive assessment of children's organization, planning, and task management skills. The scales include parent (COSS-P), teacher (COSS-T), and student (COSS-S) versions. The COSS assesses a child's overall competence in managing tasks at home and school; indicates how frequently a child uses proactive steps; delineates competence in planning tasks, tracking assignments, and managing materials and time; identifies a child's organizational strengths and weaknesses relative to a normative sample; and assesses the level of conflict at home related to a child's organizational problems. The COSS-P has good psychometric properties, with 2-week test–retest scale reliabilities of between .92 and .94, and internal consistency with Cronbach's alpha ranging from .90 to .95 (Abikoff & Gallagher, 2009). The parent version of the COSS was used as an overall screen for organizational skills deficits for the children who participated in the present study.

Results of Screening Measures

Table 3 shows the means and standard deviations from these screening measures for the children in this study, along with the norms for the measures. The third column

shows the standardized mean difference (SMD) between the mean for children in the camp and the norms for each measure. The fourth column shows the 95% confidence intervals for the SMD based on the study sample and the normed data. A plus sign (+) indicates that the study participants had an overall higher severity score as compared with the norms for the measures.

All of the results in Table 3 are based on parent ratings. The results show that as a group ($N = 16$) the parents rated their children 1.6 standard deviations above the norm on the SDQ hyperactivity and inattention scale, and 3.8 standard deviations above the norm on the ASSQ the measure used to assess HFASD. In addition, the COSS was used as a measure of organizational skills deficits. On the COSS Parents rated their children 1.6 standard deviations above the norm on the Total Score scale, 2.1 standard deviations above the norm on the Task Planning scale, and 1.7 standard deviations above the norm on the Memory and Materials Management scale. In addition, parents rated their children .33 standard deviations above the norm on the Organized Actions scale. One possible explanation for this smaller SMD difference as compared to the other COSS scales is that the questions that comprise this scale focus on here-and-now actions.

Table 3 Results of Children's Assessment Measures

| Measure ($N = 16$) | Study *M* (*SD*) | Norms *M (SD*) | SMD | 95% CI |
|---|---|---|---|---|
| SDQ (hyperactivity/inattention) | 6.7 (2.5) | 2.8 (2.5) | +1.6 | 1.51, 1.61 |
| ASSQ (autism spectrum disorder) | 24.5 (10.9) | 3.3 (4.5) | +3.8 | 2.8, 4.7 |
| COSS Total Score | 161.8 (23.4) | 115.8 (30.4) | +1.6 | -1.1, 4.2 |
| Organized Actions | 28.5 (3.6) | 26.2 (7.1) | +.33 | -0.3, 0.9 |
| Task Planning | 18.9 (4.8) | 10.4 (4.0) | +2.1 | 1.7, 2.4 |
| Memory and Materials | 24.5 (5.7) | 15.5 (5.3) | +1.7 | 1.2, 2.2 |

Children with ADHD and HFASD have greater difficulty with organizational skills such as planning that require delayed or lengthy temporal management versus immediate action. The number of children above a cutoff point for hyperactivity/inattention and HFASD are not reported. The research questions for this exploratory usability test were primarily directed at evaluation of the users (children and parents) interactions with the prototype product; therefore, differentially assessing ADHD and HFASD and the relative impact of the product was not feasible or a central focus. The screening measures were used to evaluate the overall severity of ADHD, HFASD, and organizational skills deficits for the children who participated in the study. The prototype that was tested is described in the next section.

Description of the Prototype

Jodi Morstein, of the University of Utah College of Nursing, created the concept for the mobile technology. Lee Hollaar, of the University of Utah School of Computing, developed the prototype used in this usability test. The prototype was designed to serve as a task list of items to bring to camp in the morning and to take home at the end of the day. The task list was programmed on an Apple iPod touch® system. The iPod touch is less complicated to program than other smartphone platforms and Apple provides programming tools at little or no cost. In addition, the iPod touch is a popular device for children and is reasonably priced for many families (L. Hollaar, personal communication, April 2010).

The iPod prototype did not include Internet (wireless or mobile) capability due to the extensive time required for website design to integrate communication between the child's device, the teacher/camp, and the parent. In addition, the school where the camp

was located would not allow access to the Internet. Therefore, Internet capability was simulated through two paper prototypes. Therefore, Internet capability was simulated through two paper prototypes. First, a child log was created for collecting daily morning iPod usage data. The iPods were manually checked each morning with data entered into the paper child log. This simulated data collection that was originally planned to be collected automatically through the Internet. Second, a parent evening log was created in which parents entered use data that in the original plan would have been collected automatically via the Internet.

The prototype application included two iPod screens: (a) a task list with touch boxes for items to bring to camp and to take home each day, and (b) a subscreen for typing in the name of a homework assignment along with a page number. Figure 1 depicts the iPod prototype with the two screens that were used for task tracking in the usability test.

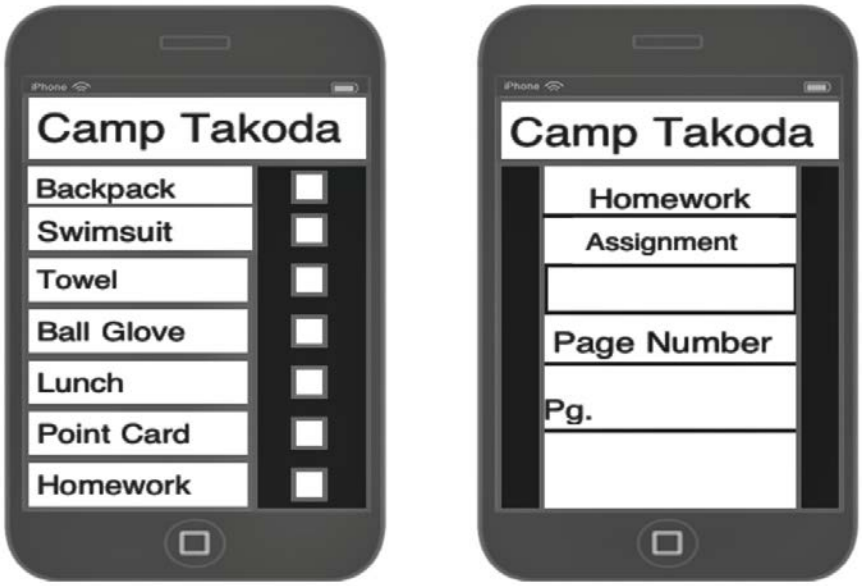


Figure 1 Depiction of the iPod Touch Task List

## Measures and Data Analysis Plan

The research questions for this study focused on the extent to which children and parents would utilize, value, and support the use of the technology. In this study utilization was related to effectiveness and efficiency. Effectiveness is typically measured by binary task completion (Hornbæk, 2006). The homework completion portion of this study represents a binary task completion method for assessing effectiveness. In an excellent review of 180 usability studies, Hornbæk (2006) pointed out that subjective perceptions of outcome and potential for improving a situation are also measures of effectiveness; however, these are often not included in usability studies. In this study children and parents qualitative responses related to quality of outcome and potential of the software are also integrated into qualitative themes and considered as measures of effectiveness.

Efficiency typically refers to time to complete a task; however, because this study involved testing an early prototype, time to complete tasks was not an important measure. The overall rates of usage to relate to efficiency with the rationale that usage is indicative of the energy and resources the children and parents used to complete the tasks. This is consistent with the recommendation of Hornbæk (2006) who emphasized that efficiency extends beyond simple concepts such as time to complete tasks. Efficiency includes objective and subjective dimensions such as perceptions of time to complete tasks, mental effort, and perception of task difficulty. Efficiency was measured by overall usage and subjective reports regarding the efficiency of the prototype and of the fully developed product concept.

Satisfaction is typically measured qualitatively by evaluating users' attitudes and experience using a product. In his review Hornbæk (2006) noted that very few standardized measures for satisfaction exist, and those that do exist often do not fit the testing context and are seldom used. He found that many studies use researcher designed Likert scales. This was the approach taken in this study. In addition, Hornbæk (2006) listed more than 90 terms used to define satisfaction. In this study the construct of valuing is used in the research questions to define satisfaction. Although the primary construct to evaluate satisfaction was valuing, several of the qualitative themes that emerged included additional constructs that can be related to satisfaction.

In this study satisfaction was related to the construct of valuing, and assessed through the use of focus groups and surveys. The focus groups with children and parents were the primary method used to gather information related to satisfaction with the technology. In addition, the surveys with Likert scales were designed to assess valuing of features by parents and children. Although the surveys were primarily directed at assessing features, the responses from parents and children may also be viewed as perceptions of what features are valued and/or satisfying.

Five measures were developed to address the research questions: (a) a daily child log was created to gather data related to actual use; (b) an evening parent log was designed to assess parent participation and child evening use; (c) the standard camp database was used to gather data on homework completion, with these data used for an analysis related to the potential effectiveness of the device for task tracking and completion; (d) parent and child surveys with Likert scales were designed to assess interest in, and value of, current and proposed features; (e) parent and child focus groups

were conducted to assess subjective views of effectiveness and efficiency such as perceived outcome of the prototype and potential of use of a fully developed technology. In addition, the focus groups evaluated satisfaction in terms of participants valuing the product idea and support for current and planned features. These measures operationalize the research question constructs of utilize, value, and support as related to the overall usability concepts of effectiveness, efficiency, and satisfaction. Each of these measures, corresponding data analysis methods, and the overall reliability analysis for focus group coding are described in the following sections.

Child Daily Log

The primary quantitative data source to assess utilization was the daily log of iPod task list use that was completed each morning when children came to camp. Recorded on this log were the number of children present, number of iPods lost or forgotten, number of items checked on the bring-to-camp task list, number of items unchecked, and items incorrectly checked on the iPod task as present, but actually missing.

In addition, it is important to note that this author also collected qualitative data in the form of direct quotes from children on each log. When children came to camp in the morning they were asked simple nonintrusive conversational questions related to iPod and task list use. Examples of the questions include: Where's your iPod? How'd it go with the task list? When did you do the task list? The responses to these questions are included in Appendix D (Focus Group Questions and Responses).

Parent Daily Log

The task list on the iPod was cleared each morning in order to be used again to check for items to take home prior to leaving in the afternoon. During initial study planning, consideration was given to having parents reward children with iPod time contingent upon completing the take home task list and having all items present before leaving camp in the afternoon. At the second weekly parent training meeting, the parent daily the log was reviewed and parents practiced completing it. The parents were instructed that it would be placed in the bag with their child's homework to be taken home, completed, and returned the following day.

Following the first day of data collection it was determined that it would be difficult for parents to check tasks by paper and pencil and assign play time based on point values for each completed task. Therefore, the decision was made to use the daily parent log as a means of gathering overall utilization data and to allow parents to choose whether or not to use the iPod as reward for behavior. Similar to the child log, the parent log section for verifying items that were brought home was a method of simulating Internet capability.

During the second parent meeting a daily report card (DRC) was developed for each child in the camp. The DRC process involved identifying several behaviors that were problematic at camp, tracking these during the day, and having parents provide rewards for goal achievement in the evening. Parents were informed that they could use iPod play time, along with other rewards consistent with their family, as a reward for meeting DRC goals.

The daily parent log including asking if the iPod was used as a reward for DRC goal attainment and/or for noncontingent free play time, as well as how many minutes it was used in each way. In addition, parents were asked to complete Likert scale questions to assess how much interest their children showed in using the iPod as a reward for goal achievement and/or for noncontingent free play. The parent daily log is included in Appendix B (Child and Parent Logs).

Data analysis method for daily logs. The child and parent logs are primarily measures of utilization that relate to research questions #1 and #2. The constructs related to usability which these address are effectiveness and efficiency. Descriptive statistics were used to summarize the quantitative data from these logs. These data are reported primarily through the use of tables in Chapter 5. The qualitative responses children made related to the daily log were analyzed using the general inductive approach described in the focus group section situated later in this chapter.

## Homework Completion

Pelham, Greiner, and Gnagy's (2004) work with ADHD children in STPs described homework completion and accuracy for 45 children who served as a nonADHD comparison group. The nonADHD comparison group demonstrated homework completion rates of 90%, with an accuracy of 80% or greater, during the 8-week camp period. During Camp Takoda's 1st year (2009), the average homework completion rate for children with ADHD and HFASD was 62%.

In this usability test homework was used as a measure of binary task completion related to utilization and potential effectiveness. The usual procedure as children entered

the classroom was for homework to be collected, scored, and then entered into the camp database. This procedure was followed throughout all 15 days of the usability test.

The research team determined the iPod and task list would be used in two ways related to homework completion. First, during the initial 8 days of the test the iPod was used without a contingency between (a) use of the task list, and (b) device game time. This provided a measure of whether or not the children would use the task list for tracking homework, and it provided an initial measure of the impact of using the iPod and task list.

During the second 7 days of the usability test a contingency was created between (a) use of the iPod task list and homework completion and (b) device game time. For this period, the research team decided that children would earn 20 minutes of game time if they used the iPod task list and returned their homework; if they did not use the task list and return their homework they would lose 10 minutes of game play time. This provided a measure of the impact of using the iPod as a contingent reward for completing a task.

Chapter 1 of this dissertation emphasized the need for contingent point of performance rewards for children with ADHD. The introduction of a contingency between homework completion and game play established a point of performance contingency for completing homework. The rationale for this design was to assess the rate of homework completion without a contingent reward, as compared to with contingent reward.

This approach led to homework completion analysis being divided into four time periods. Period 1, which included the first 5 iPod orientation days, was used as a baseline for homework return. During the baseline period, the iPod and task list was not used.

Period 2 included the first 8 days of the usability test when the iPod and task list were used to track items to be brought to camp. Importantly, during this period no contingency was established between successful homework completion and iPod game play time.

Period 3 included the next 7 days, during which time a contingency between homework return and game time was introduced. If homework was not entered into the task list, work completed, and brought back the next day, the child lost 10 minutes of game time. This accounted for approximately half of the game time. Children who lost 10 minutes of game time were allowed to choose a book to read during the lost time.

Period 4 included the final 5 days of camp during which the iPods were no longer used. For homework completion, this phase was considered an intervention withdrawal or return to baseline period. This sequencing of days created an A-B-C-A design for homework completion analysis.

Data analysis method for homework completion. The homework completion portion of the study was longitudinal as it included a 5-day baseline period, the two intervention periods which totaled 15 days, and a 5-day intervention withdrawal baseline period. The resulting data from these days were analyzed using the generalized linear model and inferential statistics. Homework completion rates between periods were considered probabilistically in order to gain an initial understanding of the potential effectiveness on behavior change related to the prototype mobile technology.

During periods 2 and 3 of the usability test homework completion was considered a dependent variable. The use of the iPod, followed by use of the iPod plus game time contingent upon homework completion, were considered as two levels of an independent

variable. Because the process involved repeated observations for each child within each period of time, generalized estimating equations were used for the data analysis.

Generalized estimating equations are useful in longitudinal studies such as this because they take into account correlation between observations. For the analysis each day was considered separately, with homework completion modeled as a binary logistic response. Days were considered to be repeated observations within individual participants. An autoregressive term was specified to represent the assumption that for any child adjacent days would be more highly correlated than days further apart. The first 5 orientation days were considered as a baseline against which the other time periods would be compared.

Parent and Child Surveys

A parent survey and child survey were designed by the primary investigator and this author. The parent survey consisted of 20 questions that were key features included in the vision for the impact model or fully developed technology. The list of features was developed over a period of several years based on knowledge and experience gained from working with children with ADHD. In essence, they are artifacts of the creativity of the innovator, Jodi Morstein. A 5-point Likert scale was used for parents to evaluate the importance of these 20 features. Parents completed the survey at the outset of the second focus group. They were completed by family; therefore, there were 16 surveys completed.

Likewise, an 11-question child survey based on the planned software features was developed. The same Likert scale was used as with the parent survey. The survey was

given to children on two separate days with 5 or 6 questions asked each day prior to the start of iPod game play time. This created a condition that followed the Premack principle (Kearney, 2007) with the survey questions and focus group held first, followed by game time which was undoubtedly more rewarding.

When the survey was administered, the children sat in a 4 x 4 pattern of desks in the classroom. This made it easy to observe the children as they answered the questions. After the purpose of the survey was explained the questions were read aloud, then the children were asked to choose the answer that best fit with what they felt or thought. The children appeared to be thoughtful in choosing responses to questions. The survey instruments are included in Appendix C (Child and Parent Surveys).

Data analysis method for surveys. The child and parent surveys were analyzed using descriptive statistics. Because there were only 15 or 16 surveys and the purpose was to get a sense of support, or lack of support, for features of the prototype and proposed technology, the responses were split into two categories. The first category label "less important," included the survey responses of *not important, important, somewhat important*; and the second category label "more important," included the survey responses of *important and very important*. For the purpose of ideas for future design this created a binary where all responses were included and rank ordered from the highest endorsement to the lowest.

## Focus Groups and Qualitative Data Analysis

During the 4th week of the usability test, this researcher held two 15-minute focus groups with the children before the start of the iPod game time period. The focus groups

were centered around the survey described in the previous section. During each focus group, children answered five or six questions and were then asked a few related open-ended questions. This method was selected based on the need for structured conversation, the children's short attention spans urgency to have the reward of iPod game time. The aim was to gain a foundational understanding of their valuing of aspects of the technology. The focus groups were videotaped by a counselor and transcribed by this author. The list of questions developed for these focus groups is included in Appendix D (Focus Group Questions and Responses).

Two 30-45-minute parent focus groups were held at parent training meetings. The parent focus groups were intended to elicit feedback related to planned features and perceptions regarding the value of the device. The first focus group was held on the 10th day of the usability test at the regular parent meeting with the primary investigator serving as the facilitator. The focus group was focused on how the iPod task list was working, parent perceptions of their child's interest and use of the technology, and parent feedback related to valuing the technology concept.

Thirty-five parents attended. This large number of attendees and the limited time for the focus groups (45 minutes) impacted the ability to stay with one topic and get in-depth responses. At the outset of this focus group, parents were informed that a second focus group would be held to get their feedback regarding future development of the software.

The second focus group was held during the last week of the study. The primary investigator started this group with a brief PowerPoint presentation of the fully developed idea for the software. Following this the primary investigator and a software developer

facilitated the focus group. This author videotaped and transcribed both parent focus groups. The list of questions developed for these focus groups and the responses are included in Appendix D (Focus Group Questions and Responses).

Method of focus group analysis: A general inductive approach. The focus groups were designed to gather feedback related to use, parent and child valuing of the technology, and to evaluate current and planned features for future design. The method for focus group analysis, a general inductive approach, was selected based on its being suitable for product evaluation and design research. The background for selecting this method, and the procedures for using it, are described in the following paragraphs.

The traditional approach to qualitative research typically begins with a description of an overarching research paradigm and a detailed description of a specific methodology. This is followed by a description of an approach to data collection and analysis that often involves comprehensive and complex thematic coding. As with quantitative social science research, traditional social science qualitative research methods (e.g., ethnography, case studies, narrative research, grounded theory, phenomenology, participatory action research) focus on theory and knowledge development rather than on evaluation and product design (Creswell, Hanson, Plano, & Morales, 2007; Rubin & Chisnell, 2008).

For design research that focuses on answering practical questions within a short time frame, an alternative qualitative approach is needed. In relation to design research in general, Hornbæk (2010) emphasized that technology research must focus on product evaluation, use quantitative as well as qualitative methods, and not become bogged down in broad theoretical issues at the expense of further product design. In addition, scholars

have emphasized that formative design research requires a method of qualitative data analysis that is brief, nontechnical, efficient, and defensible (Bruseberg & McDonagh-Philip, 2002; Kontio, Lehtola, & Bragge, 2004; Thomas, 2006).

In traditional qualitative research, the time demand for rapid reporting of results is typically not required. In formative usability testing there typically is a demand for fairly rapid analysis and reporting to inform further product design. This necessitates a qualitative method that balances rigor with relevance for the design context (Ivarsson & Gorschek, 2011).

In response to the need for a straightforward method for analyzing qualitative data for evaluation purposes, Thomas (2006) developed a general inductive approach. This method provides a relatively straightforward and nontechnical (e.g., multiple coders using computer software) approach to condensing raw data and relating findings to research questions. The general inductive approach was developed for evaluation projects in which the analysis is likely to be closely tied to research questions; however, it does allow for more unstructured and goal-free analyses as well.

The general inductive approach has many similarities with other qualitative approaches (e.g., grounded theory, discourse analysis, phenomenology). In addition, it is situated broadly within a critical realist framework. However, in contrast to traditional paradigms and methods, the general inductive approach is a qualitative method geared specifically to evaluation research. It does not include a detailed description of a research paradigm, outline methods for goal-free analysis, and may or may not use more labor-intensive methods of data analysis such as the use of software programs.

An underlying assumption of the general inductive approach is that the inquiry will identify themes related directly to the research questions. However, the data are approached with flexibility and open-mindedness to allow room for additional emergent themes not related to the research questions. Consistent with most qualitative research methods, a deductive and an inductive process are involved. The general inductive approach is explicit in assuming that the research includes elements of deduction related to the research questions from the outset, with the goal to work diligently to not become bootstrapped into an exclusively deductive analysis (Thomas, 2006).

Thomas (2006) described some of the analytic strategies of the general inductive approach as follows: (a) data analysis is guided by the research questions, but not limited to the research questions as other findings may emerge; (b) the main mode of analysis is to develop categories from the raw data; (c) findings are developed from multiple readings of the raw data, with the evaluator making decisions as to what is important and what is not in the data; (d) different evaluators may develop different categories from the data; and (e) the trustworthiness of the data can be evaluated using techniques similar to other qualitative data analysis methods.

The products of the general inductive approach include (a) a category label that is a word or a short descriptive phrase, (b) a category description, (c) text related to the category, (d) links to other categories with some model developed if necessary, and (e) a linking of the themes to the research objectives of the study (Thomas, 2006).

The practice of the general inductive approach includes five steps: (a) preparation of raw data; (b) close reading of the text; (c) creation of categories with the upper-level themes typically related closely to research objectives; (d) dealing with overlapping

coding and uncoded text, recognizing that because the method focuses on addressing specific questions as much as 50% of the text may not be used as it may not be relevant to the evaluation objectives; and (e) ongoing refinement of the categories, with three to eight described as the most reasonable amount for a completed analysis (Thomas, 2006).

Additionally, trustworthiness of the results from a general inductive approach can be evaluated similar to other qualitative research. Guba and Lincoln (1994) described four types of trustworthiness: dependability, transferability, credibility, and confirmability. In the general inductive approach methods for auditing and establishing confirmability and credibility in the process of data analysis include member checks and interrater reliability checks. Methods for interrater reliability checks include (a) independent parallel coding, (b) checking on category consistency, and (c) stakeholder checks (Thomas, 2006). The method for checking interrater reliability used in the present study was checking on category consistency. The application of Thomas's (2006) general inductive approach to the present study is described in the following section.

Focus group results analysis: Reliability. The qualitative responses from the focus groups were analyzed according to the general inductive approach for evaluation research outlined above. All responses from children and parents were transcribed and entered into a three-column format. The text was read through multiple times with three formal readings completed over 2 days by this author. During the first formal reading the text was coded into key words in the first column, during the second reading key words were combined into a set of initial themes, and during the third reading these themes were combined reducing the themes to a total of six.

Importantly, two additional themes were identified from the brief comments that children made when they arrived at camp each day. One additional theme came from several comments made by parents at the close of the first focus group. The text that led to this theme was inadvertently left off the transcripts that were given to the additional readers. However, the theme was very salient and included in the results.

Following the general inductive approach outlined by Thomas (2006), themes were identified by considering parent or child verbal responses, and thereafter by reflecting on the research questions (objectives) for the study. To be consistent with the general inductive approach, text that was not clearly related to the research questions was not included in the analysis. Thomas (2006) suggested that such text may account for up to 50% of the qualitative responses. In the present study, an estimated 15% of the qualitative responses text was discarded. The discarded text included primarily tangential comments made by children or parents. The qualitative text included for analysis is included in Appendix D (Focus Group Questions and Responses).

For a reliability analysis, the initial six themes that were generated from the author's readings were listed on one sheet of paper. The transcribed responses from children and parents were listed on separate sheets of paper and stapled together. Two coders—JM, the primary investigator who created the initial idea for the device, and KG, who served as a camp counselor—were given the page with the themes and the stapled pages of responses. A brief explanation of the process for coding – assigning themes to the appropriate column and responses was provided when the transcripts and themes were sent to the JM and KG. JM and KG then independently assigned the themes to the text.

After JM and KG coded all of the responses, the consistency of assignment of themes to similar text blocks by all three coders (JM, KG, and this author) was calculated using Fleiss' kappa. Fleiss' kappa determines the rate of agreement among multiple raters, accounting for the level of agreement that would occur by chance (Geertzen, 2012). The raw observed level of agreement across all three raters was 0.796. The expected chance rate of agreement using three raters with this number of observations was 0.211. The final interrater agreement using Fleiss' Kappa with the chance agreement factored out was 0.741.

Table 4 shows Fleiss' interrater reliability statistics for assigning themes to the qualitative responses from children and parents. A commonly used table for interpreting kappa suggests that values from 0.61 to 0.80 indicate substantial agreement among raters (Landis & Koch, 1977). Therefore, for the present study Fleiss' Kappa of 0.74 suggests substantial interrater reliability of agreement in assigning themes to text by the three coders (JM, KG, and this author).

Table 4 Fleiss' Kappa for Interrater Reliability

| 3 Raters | Fleiss' Kappa | Pairwise average |
|---|---|---|
| 67 Blocks of Text<br>201 Decisions<br>No missing data | A_obs = 0.796<br>A_exp = 0.211<br>Kappa = 0.741 | Observed agreement<br>79.6% |

## Procedures for Usability Testing

Parents were provided a basic description of the planned research study during admission interviews. The camp included a weekly 90-minute parent training meeting. At the initial parent meeting, the study was presented and the informed consent document reviewed. Parents were informed they could choose to sign the consent form at the end of the meeting, stay after the meeting to ask additional questions, or take the consent form home and return the signed form within several days. Parents were informed that if they chose not to participate in the study, their child would still be given an iPod to play with during the designated game play period of camp. The parents of all 16 children completed the consent form within 3 days.

The protocol for the usability test included several days for familiarizing the children with the iPod. On the 1st day of this orientation period, the study was explained to the children by the primary investigator and this author. All 16 children gave their assent to participate in the study. Following this, a counselor familiar with the iPod introduced the children to the device and to several games. All of the children were able to navigate menus and select games and music within 5 minutes of receiving basic instructions. At the end of this initial orientation, children were given 15 minutes to listen to music (Disney Soundtrack from *Up*) or play a game (*Shrek Kart* or *Phineas and Ferb Arcade*).

Within 3 minutes of starting iPod play time, all 16 children had their headphones on and were quietly playing games or listening to music. A silent room filled with 16 children with ADHD and HFASD is a highly unusual occurrence. One counselor commented, "The silence is almost weird," and noted that the children were captivated by

playing with their iPods. A second counselor commented, "This is amazing," referring to the focus and concentration of the children.

On days 2 through 4 of the orientation period, this author introduced the task list and helped the children practice completing it. The practice period lasted for approximately 10 minutes on 3 successive days. On these orientation days practice with the task list was followed by 10 minutes of free time for playing games on the iPod. On the second day, the author noticed 3 boys sitting closely together and talking quietly. One of the boys said to a peer, "Dude, how did you get all of those characters?" The boys then began talking and comparing which strategies worked best to succeed when playing the game.

Day 4 of the orientation period was an overnight trial of the basic task list completion protocol. Each child's iPod was placed on his or her desk in the ALC classroom. At the end of the seatwork period, each child entered a homework assignment on the iPod homework screen. At the end of the day, each child took his or her iPod home with a verbal reminder to complete the task list in the morning and to bring the iPod back to camp. All children returned their iPods the following day. The child daily log was completed by this author. Because this was a pilot test the results were not included in the study.

The original study plan included converting checked off task list items to incremental minutes of game time. Prior to starting the 15-day prototype trial, the research team and camp staff decided not to convert task list checks to minutes for game time during the iPod play period. It was determined to be too difficult to track varied minutes of time across 16 children while also operating a demanding camp schedule.

In addition, the team felt that direct conversion of task list items completed to minutes of game time could potentially create unnecessary distress and opposition when children were disappointed with the amount of game time they had earned compared with their peers. The team discussed that use of a fully developed device would involve contingencies among a parent, teacher, and child without peer group scrutiny. It was agreed to follow through with the planned homework completion trial in which receiving 10 minutes of game time was contingent upon using the iPod task list and turning in completed homework.

The team decided, however, that a relatively small number of points would be added to each child's daily camp score based on bringing the iPod to camp and completing the task list. Children earned up to 3000 points or more each day during the camp. Points earned at camp led to daily rewards such as "high point kid" and counted toward earning a Friday field trip. The team decided that children would receive up to 125 additional points for bringing their iPod to camp and for completing the task list. This was designed with the thought it would increase the likelihood that iPods were returned and serve as a point of performance reward for bringing the iPod to camp and completing the task list.

Actual use of the iPod and task list started on the 1st camp day after the orientation period. In the results section this is labeled as Day 1 of the usability test. Children attended camp 5 days per week. However, the iPod was only used from Monday through Thursday. Each Friday children left early for a field trip, homework was not assigned, and iPods were not taken home over the weekend. After data collection and game time on Friday morning the iPods were collected. This created a pattern where the

1st data collection day was Tuesday and the last data collection day Friday morning for the period of the usability test. This resulted in the 15-day test taking place over 4 weeks.

As described in the measures section of this chapter, for the first 7 days of the test the iPod was used for task tracking without a contingency between homework completion and game time. However, during the next 8 days a contingency between homework completion and game time was created.

From the outset of the usability test, a homework assignment was written on the board at the front of the classroom after the first school period. At the end of the second school period, and before iPod game time, children were verbally prompted to record this assignment on their iPod task list. When the children returned from swimming in the afternoon an alarm sounded prompting them to collect their belongings, including homework, and to check them off on the task list. In the evening, parents verified that the items were present by checking them off on the daily parent log found in Appendix B (Child and Parent Daily Logs).

Parents agreed to set the iPod alarms to sound in the morning 15 minutes before it was time to leave for camp. In addition, parents were advised to give their children one prompt to complete the task list and gather their take-home items. When children arrived at camp in the morning, this author checked the iPods for task list completion, quickly verified whether or not they actually brought the items that were checked, and asked simple open-ended questions related to their iPod use. Finally, the task list was cleared for the day.

The children's iPods were charged for several hours and returned to their desks for the classroom periods. After the third ALC period of game play time, the iPods were

collected, placed back on their chargers, and alarms set for 4:15 pm to remind children to find their backpacks and gather items to take home. This process was followed for all 15 days of the usability test with daily data collection occurring through the use of the child daily log, parent daily log, and homework completion database.

## Triangulation and Chapter Summary

Consistent with field-testing, the goal was to allow children and parents to use the iPod according to the test plan without multiple prompts, coaching, or corrections and sanctions for nonuse. This approach to usability testing has been described as similar to ethnography in that the researcher is unobtrusive in data gathering and participation in the study (Hornbæk, 2006; Millen, 2000).

The research questions were directed at use and valuing of the technology by children (research question #1), by parents (research question #2), and interest in features by parents and children (research question #3). The design of the study included developing qualitative and quantitative measures for each research question. For example, the children's log included quantitative utilization data and qualitative responses from the children upon their arrival to camp (research question #1). The parent log included quantitative utilization data, and the parent focus groups addressed parent subjective responses regarding utilization and value (research question #2).

Whether at the level of theoretical paradigms, methods, data, results, and conclusions, the issue of triangulation is an issue that has received a great deal of attention in the social sciences literature. A basic definition of triangulation provided by Denzin (1970) was, "the combination of methodologies in the study of the same

phenomenon" (p. 299). Denzin (1970) argued that combining methodologies was crucial for knowledge and theory building in the social sciences. During this early period of development of mixed methods approaches to research, Jick (1979) discussed triangulation in theory and practical application. He discussed multiple approaches to triangulation including using complimentary methods such as interviews and observation. In addition, Jick (1979) described the goal of triangulation as being to discover congruent findings and strengthen validity of a study.

However, Jick (1979) also pointed out that triangulation may be viewed in a more holistic way as a means to discover unique perspectives not ascertainable by quantitative methods alone. From the 1980s onward, although mixed quantitative and qualitative methods were used in many disciplines, an ongoing debate has occurred as to the compatibility of paradigms, value of types of data, and utility of results (Denzin, 2012). In his article titled, *Triangulation 2.0*, Denzin (2012) revisited the controversies that have surrounded the concept of triangulation as related to research paradigms and as conceptualized in mixed methods research. In his conclusion, Denzin (2012) emphasized that regardless of the matters of debate, the goal of using multiple methods and triangulation of findings was to take beneficial action in the world.

In the field of human computer interaction (HCI) triangulation of data and methods as a strategy to improve the results of usability tests has also been a matter of discussion (Lindroth, Nilsson, & Rasmussen, 2001; Mackay, 1998; Wilson, 2006). However, a distinct difference as compared to the social science literature is that the discussion of triangulation in the HCI literature does not become bogged down in what Denzin (2012) calls "paradigm wars" (p. 84). This may be a result of the focus of HCI

and usability testing being on the evaluation and further design of real world products versus generating theoretical knowledge.

In the field of HCI, MacKay (1998) emphasized gathering quantitative and qualitative data as a valuable approach to triangulation in usability tests. She defined triangulation as gathering data and drawing tentative conclusions from multiple data sources, and emphasized that the goal of triangulation was to inform design. Wilson (2006) emphasized triangulating data by methods such as questionnaires, logs, and focus groups and then working to become a "data aggregator" (p.63) documenting convergence, or lack thereof, across sources to improve design. In addition, Wilson (2006) suggested triangulating data by comparing quantitative and qualitative data, and consistent with Denzin (2012) qualitative and quantitative are viewed as types of data, and not as contrasting or competing paradigms.

Consistent with HCI and usability testing, triangulation in this study involved creating both quantitative and qualitative data collection methods for each research question and analyzing data to look for common themes and contrasts. The goal in design and triangulating data was to have a more robust method for evaluating the prototype, assess feasibility, and inform design.

The approach to triangulation used in this study was also a matter of what Fiske (1979) described as a sensitive interpretation of the data within some reasonable framework. According to Jick (1979), the goal of triangulation is not simply to increase reliability and validate findings, but to add depth and richness of understanding of a phenomenon.

In the next chapter the results of the study are presented by research question. The first basic step of triangulation is evident as both qualitative and quantitative results are presented for each research question. However, the heart of triangulation occurs in the concluding chapter where convergence of results is discussed for each research question and the implications of the study are presented.

# CHAPTER 5

# RESULTS

This chapter summarizes the quantitative and qualitative findings by research question. Organizing results by research question was a method suggested by Rubin and Chisnell in their seminal *Handbook of Usability Testing* (2008). Each research question contains multiple constructs (e.g., utilize, value, and improve task completion) and multiple data sources with both qualitative and quantitative data collected. In this chapter the research question constructs are lettered (a), (b), and so on. The constructs contained in each research question are used as the headings. These headings are designated as RQ#1(a), RQ#1(b), RQ#2(a), and so on.

In addition, the research questions applied to either children or parents. The qualitative themes will be designated as a "Child Theme" if they emerged from, or relate to, children; and as a "Parent Theme" if they emerged from, or relate to, parents. Finally, the qualitative results will follow the general inductive approach by including a category label (the section heading) that is a short descriptive phrase, a category description, and text from participants related to the category (Thomas, 2006).

## Research Question #1 Children and Usability

Will children with ADHD and HFASD (a) utilize, and (b) value a mobile technology designed to assist with organization, planning, and task management; and (c) will utilization improve task completion?

### RQ#1(a) Utilize – Children's Daily Log

The children's daily log was the primary data source for measuring utilization. Results across the group showed that out of the 210 times (199 + 11) the iPod was expected to be brought to camp, children lost or forgot the device 11 times. Children brought their iPods 95% of the time and forgot or lost them 5% of the time. In addition, measuring utilization via task list completion showed that out of 1,295 items to be checked, 239 were left unchecked. This represents an 82% rate of completing the iPod task list and a 18% rate of failure to complete the task list. These data are provided in Table 5.

Importantly, instances of the task list not being completed were typically a result of forgetting or failing to complete the entire list. When single items were left unchecked, children often said they did not check the items because they could not find them or they forgot them. Viewed another way, the mean number of unchecked items per morning was 15. There were 7 items on the task list, which suggests that on average 2 children per day did not complete the task list. Based on these morning log data, overall utilization of the iPod task list was high. This high rate of completion may have been partially a consequence of the children knowing the task list would be checked each morning and a result of the ability to earn a small number of camp points.

Table 5 Child iPod Utilization Based on Daily Logs

| Usability test day | Children absent | Lost or forgotten iPod | Children using task list | Total bring-to-camp items[a] | Items not checked |
|---|---|---|---|---|---|
| 1 | 3 | 1 | 12 | 84 | 11 |
| 2 | 1 | 2 | 13 | 91 | 7 |
| 3 | 0 | 1 | 15 | 105 | 8 |
| 4 | 0 | 1 | 15 | 105 | 32 |
| 5 | 1 | 0 | 15 | 105 | 33 |
| 6 | 2 | 1 | 13 | 91 | 10 |
| 7 | 5 | 1 | 10 | 70 | 16 |
| 8 | 3 | 0 | 13 | 91 | 24 |
| 9[b] | 3 | 1 | 12 | 84 | 2 |
| 10[b] | 1 | 1 | 14 | 98 | 6 |
| 11[b] | 4 | 0 | 12 | 77 | 3 |
| 12[b] | 2 | 1 | 13 | 91 | 32 |
| 13[b] | 2 | 1 | 13 | 91 | 40 |
| 14[b] | 2 | 0 | 14 | 98 | 1 |
| 15[b] | 1 | 0 | 15 | 105 | 6 |
| Total | 30 | 11 | 199 | 1,295 | 239 |
| Mean per day | 2 | .73 | 13 | 15 | 16 |
| Percent of total | — | 5% | 95% | — | 18% |

[a]Total bring-to-camp items equals the number of children present and using the iPod multiplied by the 8 items on the task list.
[b]Days when 10 minutes of iPod game time were contingent on having homework completed and returned.

The high rate of completion by the children also may have occurred as a result of parent assistance, thereby combining a child self-managed task list with parent monitoring and support. It is important to point out that the goal of data collection using the daily log was to assess utilization as a basic measure of usability efficiency and effectiveness. Importantly, this data was not used to assess effectiveness in terms of the impact on child behavior (i.e., Does the iPod and task list help children remember to bring items?).

The goal throughout the study was to primarily gather data related to child and parent interaction with, and perceptions of, the prototype and potential technology. For field-based usability testing Oulasvirta (2012) recommended focusing first on evaluating user interaction with a technology and described this as *first order* testing. He differentiated this from *second order* testing focused on evaluating the impact of a technology on the user.

The task list was very basic, data had to be gathered quickly, and it was not feasible to assess effectiveness on the user in this portion of the usability test. Effectiveness in terms of potential impact on user behavior, or *second order* evaluation (Oulasvirta, 2012) was assessed through the binary task of homework completion reported later under this research question.

RQ#1(a) Utilize – Child Theme: Self-management with Parent Support

The theme of self-managing the iPod along with parent support to complete the task list emerged from the comments made by the children when they arrived at camp in the morning. In addition, the theme of self-management with parent support also emerged from focus groups with the children and with their parents.

The children were very responsive to morning questions and at times made spontaneous announcements related to the iPod as they walked into the camp homeroom. Examples of comments regarding self-managed use include, "I did my task list at 7:40 when the alarm went off," "I use the task list to make sure I have all of my things," and "I did it this morning, I don't think it helps much."

Children also spontaneously commented as to how they completed the task list with their parents support. One child commented, "I always do the task list with my Mom to make sure I have everything." Another child described how, "I always know I have everything except two things, and Poppy tells me if I have those and I check them off." A 3rd child described how their parent made using the task list game-like by noting that, "My mom always says 'check' when I check off my things."

During the focus groups, children described how the task list spurred their memory to gather their belongings. On the other hand, at times children commented they used the task list, but said that it did not help that much. One child took the approach of describing how it did not work, but also how it did work by commenting, "Mainly it did not help me, but I would usually almost forget my homework and report card, but once we started the iPod thing it helped me remember those things." A 2nd child described the possibility of the device helping to manage tasks in the future through vibrational prompts by saying, "Well especially if it kept vibrating until I would do it [complete the task] and then I could turn it off, but sometimes I might get distracted and just turn it off, and not do it anyway." And a 3rd child related the use of the task list to the reward of having an iPod to play games with by saying, "I like the task list, but only because of the fun games we get to play, but next week you better add the game *Pocket God*."

During the parent focus groups, several parents described their child's self-management and the various ways in which they assisted their child. One parent described amazement at her son self-managing his homework by saying, "I was in absolute shock that he was doing his homework. It was incredible that I wasn't instigating it." A second parent described their child's self-management as connected to parental monitoring. This parent noted:

> For me the organizing is a step forward. Because right now he never uses a planner. And he will use it [the iPod] because he likes it. So I could manage how much time he has to use it.

In addition, another parent described how her son self-managed the device and task list based on his valuing the iPod:

> Our son thought that it was cooler to log his homework into an iTouch than a planner, so much like, … he was very consistent and I did not have to ask him. He would go right in and do his homework, log it in the iTouch and put it away in his backpack, and that worked for him, far better than the planners that the school sends home that I cannot even use.

In conclusion, the theme of the iPod and task list helping the children self-manage task lists with parent support emerged from the children's daily comments, the child focus groups, and the parent focus groups. All of the comments, whether from the child daily log or from focus groups, are coded as SM (self-management) for this theme and are included in Appendix D (Focus Group Questions and Responses). A final example of the theme of self-management came from a very bright 12-year-old girl who commented that:

> I think it helped me a lot because I am usually forgetting things, and every time I would see my iPod in the morning I would say, Oh I just remembered I forgot to do my checklist. And when I did the checklist it let me know I had all of my things.

RQ #1(a) Utilize – Child Theme: Hurrying and Forgetting

Hurrying to get ready, losing track of the iPod during the evening, and forgetting the iPod in the car are illustrative of this theme. When iPods were missing, children made comments such as "I left it in my sister's car, and now I think my Mom has it," "I think I left it in my Dad's car … I am not sure where it is," "Mom and I were hurrying to not be late and I did not have time to do it, and then I forgot my iPod in the car," and "We had to hurry, and I forgot my iPod on my nightstand."

This theme emerged from the children's daily comments when they came to camp. The comments relating to this theme were coded HF (hurrying and forgetting) by this author. They are included in Appendix D (Focus Group Questions and Responses).

RQ#1(a) Utilize – Child Theme: Hoop Jumping to Complete the Task

Finally, a third theme that emerged from the comments children made each morning when they came to camp was a quick hoop-jumping approach to task list completion. On occasion, children made comments such as, "I did my task list in the car on the way here," and "I don't really use it [the task list] that much. I just check things off though." The comments that relate to this pro forma method of using the task list were coded as HJ (hoop-jumping) by this author and are included in Appendix D (Focus Group Questions and Responses).

In addition to the morning comments that led to the emergence of this theme, the afternoon also provided a data source. At the end of the day the children completed the task list with the goal of checking off the items as they collected their belongings. The camp counselors noticed that several children discovered they could check all of the

items on the task list with one swipe of a finger. At times children were observed using this "finger-swiping" approach when they completed the task list in the afternoon.

RQ#1(b) Value – Child Theme: A Valued Possession and This Facilitates Use

This theme includes a variety of aspects, and perhaps attributes, that the children valued related to the iPod. As described in Chapter 4, validating a product as valued or satisfying may include many attributes such as likable, fun, exciting, interesting, attention getting, and so on (Hornbæk, 2006). In addition to the attributes of valuing the iPod, this theme also includes the connection that children made between valuing the iPod and using the task list.

At the outset of the first focus group, this author briefly reviewed the purpose of the iPod task list and then asked, "Was the iPod task list helpful or unhelpful for remembering to bring and take things home from camp?" A very bright 10-year-old commented, "I think maybe it helped a tiny bit, but it didn't help that much. But I think if you added some stuff it might help more." He did not have suggestions for additions. A 9-year-old boy who was quite oppositional throughout the camp said, "I don't think it helped me at all," and then added, "Hey, can you put *Pocket God* and *Angry Birds* on it for next week?"

A 12-year-old girl commented, "I think it helped me a lot because I am usually forgetting things, and every time I would see my iPod in the morning I would say, 'Oh, I just remembered I forgot to do my task list.'" She added, "And when I did the task list, it let me know I had all of my things." A 12-year-old with HFASD commented, "Mainly it did not help me, but I would usually almost forget my homework and report card, but once we started the iPod thing it helped me remember those things." Finally, a 9-year-old

boy with severe ADHD concluded, "I would not be able to remember that much, so it really helped me."

In addition to the children's responses related to valuing the iPod, parents also noticed their child's interest. For example, one parent commented, "For my son it was an ownership thing – it was far more cool to him than playing on the phone or some other thing because it was his deal. The ownership was a big deal to him." Another parent emphasized the social status and acceptance that would likely come from possessing and using an iPod. This parent noted that, "One thing that is nice about the iPod is it is something that is socially cool, so my kid has to get things signed off, and if it could be done on the iPod then he would not be marginalized, because it is a cool thing." Finally, a parent described the link between having the device, game time, and motivation by stating:

> It was the device that motivated him, he wanted the game time, and that was far more motivating to him then I will get you an ice cream, or better than hearing you are going to be in trouble if you do not do well, so the positive motivation was better than anything else.

Along with these responses from parents and children, this author frequently observed a portion of the children's game time. Within 2 minutes or less after the teacher announced that the children could play, the classroom grew silent as all children became engaged with their iPods. In accordance with the focus group responses from children and parents, this immediate engagement with the iPod speaks to the excitement, interest, likability or value children place on the possessing the iPod.

Perhaps most revealing were several children's comments at the close of the second focus group, when this author asked, "Is there anything else from using the iPod this summer, whether using the task list, or having time to play with it in class, or future

ideas, that you would like to tell me about?" A 12-year-old girl asked, "Do we get to take our iPods home to keep?" This author reminded the children that at the start of the study that had been told the iPods belonged to the University of Utah and must be returned. She responded with a mild, "Dang it." A 10-year-old boy commented, "I just want to say thanks for putting on the game *Battleship*." Another child responded, "Thanks for letting us use the iPods; they were fun." A 9-year-old boy smiled and said, "Thanks for putting on *Pocket God* even though it has a lot of murdering." The author chuckled and said he did not think any violent games had been uploaded onto the IPods. Along with several other children, the boy loudly explained that the game only involved throwing little creatures into volcanoes and sometimes your character gets eaten by giant red ants.

The last child to respond, a 12-year-old boy with fairly significant autism asked, "So, at the University of Utah, where will the iPods be? And, when I come for it, I wonder where the iPods will be, and I wonder if I could maybe play with one?" The author explained that the devices would be in storage and children would not be able to use them.

Overall these responses demonstrated the extent to which the children valued having an iPod. In general, although children made comments about the usefulness of the task list, it appears that above all, they valued the idea of being able to carry the device. The children saw the importance of the task list, but the opportunity to carry an iPod throughout the day appeared to be the most rewarding.

RQ#1(c) Improve Task Completion – Homework Analysis

As described in Chapter 4, a standard procedure in the STP was to assign daily homework that the children were expected to complete each evening and return the

following morning. Homework completion was used as an outcome variable for evaluating the potential impact of the iPod and task list on creating behavior change. In relation to the usability test construct of effectiveness, homework was used as a measure of binary task completion. The study was divided into four periods. The first 5 days were considered as a baseline period. The next 15 days of iPod use were divided into 2 intervention periods. During the last 5 days of camp the iPods were turned in. This approach created 4 periods or an A-B-C-A design.

The first 5 days of the study before the iPod was introduced were labeled period 1 or A. The next 7 days were the first intervention phase as the iPod was used for task tracking. This was labeled period 2 or B. During the third period the task list was used and part of the game time was contingent upon homework return. This was labeled period 3 or C. Finally, the iPod was withdrawn for the last 5 days of camp. This created a return to baseline that was labeled as period 4, or a second A phase.

This approach yielded binary observations of homework completion for all children who attended each day. This allowed for longitudinal homework completion analysis as the aggregated binary observations were well over 300. Homework completion data were analyzed using generalized estimating equations with logistic regression. The resulting statistics for each period are odds ratios (ORs). Parameter estimates were calculated for homework completion for each period. The resulting ORs represent the averages over all children and over all days within each period. The ORs and confidence intervals (CIs) for each time period are provided in Table 6. The baseline period is not listed in Table 6 as all periods were compared to the baseline. Figure 2 provides a boxplot depicting all four periods.

Table 6 Generalized Estimating Equation Results for Homework Completion

| Time period | Homework completion | |
|---|---|---|
| | *OR* | 95% CI |
| Period 2: iPod task list | 2.93 *** | 1.64, 5.25 |
| Period 3: iPod task list with game time contingency | 4.07 *** | 2.04, 8.12 |
| Period 4: No iPods | 0.948 | 0.467, 1.40 |

*Note.* CI = confidence interval; *OR* = odds ratio. Each time period was compared with the baseline (first 5 days). $^{***}p < .001$.

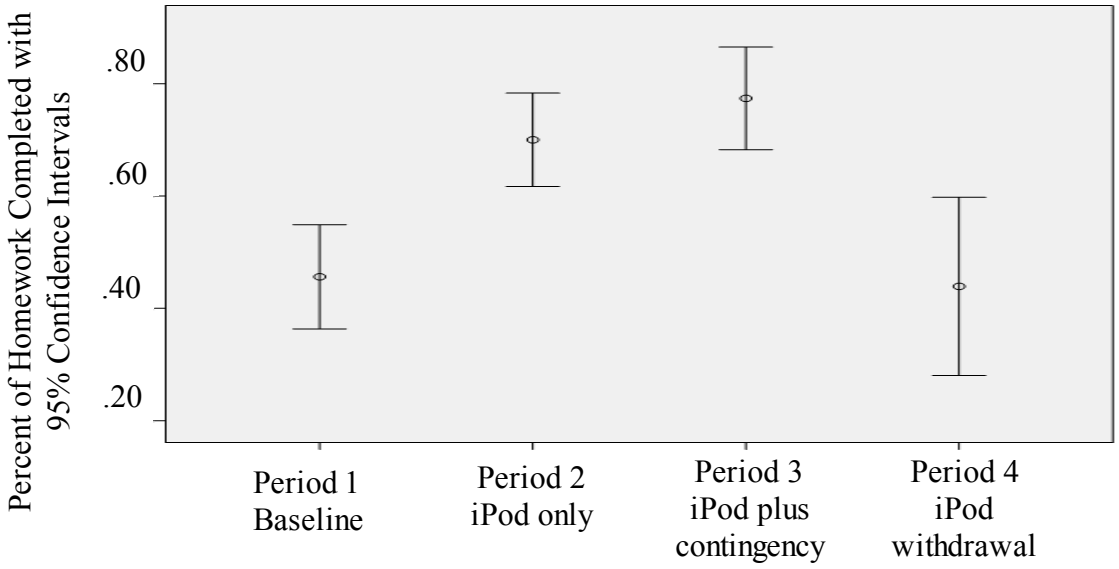


Figure 2 Boxplot for Homework Completion

Homework completion increased significantly during period 2 (iPod for tracking only), with the OR predicting an increase of 2.93 times the likelihood of homework completion compared with the baseline ($p < .001$). For period 3, when game time was contingent upon homework completion, the OR predicted an increase of 4.07 times the likelihood of homework completion ($p < .001$). In period 4, iPods were collected and children returned to the baseline phase. During this period, homework completion rates

drifted slightly below the first baseline average.

Summary for Research Question #1

Research question #1 was focused on the extent to which children would utilize, value, and potentially improve task completion using the prototype mobile technology. The data sources included the children's daily log with quantitative utilization data and qualitative comments, focus groups held with children, parent focus groups, and the homework completion analysis. The analysis in the concluding chapter will further triangulate the findings related to this research question. Table 7 provides a summary of research question #1 by construct – utilize, value, and improve task completion.

Table 7 Summary for Research Question #1 – Children and Usability

| Construct | Results Related to Children |
|---|---|
| (a) Utilize | iPod brought 95% of the time, forgot or lost 5% of the time<br>82% rate of task list completion and a 18% rate of failure<br>Child Theme: Self-management with parent support<br>Child Theme: Hurrying and forgetting<br>Child Theme: Hoop jumping to complete the task |
| (b) Value | Child Theme: A valued possession and this facilitates use<br>Period 2 – iPod and task list used results in 2.93 times the likelihood of homework completion |
| (c) Improve Task Completion | Period 3 – iPod and task list plus game time contingency results in 4.0 times the likelihood of homework completion |

## Research Question #2 Parents and Usability

Will parents (a) utilize and (b) value a mobile technology designed to assist with organization, planning, and task management?

### RQ#2(a) Utilize – Parent Daily Log

The parent daily log was sent home each afternoon in a Ziploc® bag, along with homework and other materials. In completing the daily log, parents verified that the items for camp were present 176 times. Because iPods were sent home 199 times, this demonstrates that parents completed the paper and pencil item verification checklist 88% of the time. This remarkable completion rate may be the result of having a consistent and structured process of materials management in which the log was included in the Ziploc bag that traveled to and from camp each day. In addition, this response rate may show the investment parents made to participate in the study.

Although these data show the level of parent participation, it was not possible to accurately count the number the number of items checked, present, or missing. In the original study design, these data were intended to be recorded via the Internet, with parents using the iPod to enter data onto a website. However, the development of a website was not feasible. At times, the verification list was not completed or a line was drawn down the "Yes" column, suggesting a response set when this part of the daily log was completed.

Although parents verified completion of the task list 88% of the time, they often did not complete the sections of the log related to the iPod being used as a daily report card (DRC) reward, for free play time, or to rate their child's levels of interest.

Thirty-four percent of the parents who completed this area of the log reported using the iPod as a reward for DRC goal achievement. The average was 30 of DRC reward time, with 75% of parents rating their children as highly motivated to use the device. Fifty percent of parents reported allowing their children to use the iPod for free play time, with an average use of 26 minutes. When the device was used for free play time, parents rated their children as highly interested in the device only 32% of the time. Table 8 shows the number of times the DRC reward and free play section of the logs were completed, including the number of times the iPod was used for either a DRC goal achievement reward and/or for free time, the mean minutes of use for each type, and parent ratings of their children's interest in using the iPod.

Table 8 iPod use at Home for Reward and for Free Play Time

| DRC goal achievement reward iPod use | | | | | | |
|---|---|---|---|---|---|---|
| Survey area completed | Number used for a reward No. (%) | Mean minutes of use | Rating of motivation/interest ($n$ = 32) | | | |
| | | | Not at all No. (%) | A little No. (%) | Somewhat No. (%) | Highly No. (%) |
| 106 | 36 (34) | 30 | 4 (13) | 2 (6) | 2 (6) | 24 (75) |

| Free play time iPod use | | | | | | |
|---|---|---|---|---|---|---|
| Survey area completed | Number used for free time No. (%) | Mean minutes of use | Rating of motivation/interest ($n$ = 47) | | | |
| | | | Not at all No. (%) | A little No. (%) | Somewhat No. (%) | Highly No. (%) |
| 106 | 53 (50) | 26 | 15 (32) | 7 (15) | 10 (21) | 15 (32) |

From these data it appears that parents will utilize the device for task tracking, as a reward for goal achievement, and for free play time. Interestingly, when parents used the iPod as a DRC reward they rated their children as highly interested. This may show parents' knowledge of the utility of a digital gaming device as a reward and their consequent willingness to use it in this manner.

In contrast, when parents allowed use of the iPod for free play time, they rated the interest of the children much lower. These lower ratings may be explained by children being satiated with the device, and they may also reflect that although they were playing with it, they were doing so without particularly high motivation. Overall, as with many rewards for children with ADHD and HFASD, value and interest in a reward vary.

RQ#2(a) Utilize – Parent Theme: Contingencies Help

This theme describes how the iPod was used by parents as a reward in the manner that it was designed for this study. In addition, this theme includes responses from parents when the iPod was used as a contingent reward for their child meeting other behavioral expectations. For example, a parent of a child with HFASD commented, "I reminded him last night that if he did not do his homework he would lose game time and he went and got it and did it. So it makes a difference." Another parent of a child with HFASD commented, "He does the task list in the morning, and his motivation is getting points for camp. But it does help him to remember his backpack and collect things in the morning."

Several parents described using the iPod as a contingency for both camp and noncamp related tasks. One parent commented:

> I just wanted to let you know that we are using the iPod Touch, where he can't use it on the way to camp unless he walks out of the door on time, and he has only been late once since, and before that it was three times a week easily. Then on the

> way home he has to do his homework first, and then when he gets home he has to go through the checklist that I made up where he has to hang up his towel, and take care of a few other little chores … and it is amazing the difference that it has made at home.

Another parent decided to take action to increase the reward value of the iPod by taking away other devices. This parent remarked:

> I will just tell you what I did as a parent to motivate him to use it. I took away his DS, and I took away his Wii, and I said this is going to be your form of entertainment for now, and if you do not earn it, then you do not earn it, so to motivate him to use the program and learn the benefit of using the program.

RQ#2(b) Value – Parent Theme: Reward Value Varies with Novelty

An early theme emerging from the parent focus groups was that the reward value varied based on novelty and children having access to games that attracted their attention. The first question the facilitator asked in the initial parent focus group was, "How is it going with the iPod and task list?" The first parent to respond said, "You've got good games now." Then she went on to explain that during the first 2 weeks of the usability test her son was not interested in playing the games. This increased interest in the iPod was the result of camp staff loading games suggested by the children at the end of the first week. As additional games were loaded some children became more interested in using the iPod.

In contrast, a parent of a boy with HFASD commented, "He [our son] does not care, as long as there is a game on it he is motivated to play with it. I do not even know what he is doing with it half the time, but he just wants to play the games."

A parent explained how at the end of the camp day her son is now asking, "Did I make my goals, and did I get my swimsuit [belongings]?" She added, "This is a pretty big step for him, but it has taken him 2 or 3 weeks to get to this point." She concluded,

"Right now, I think you have good game motivation." Parents noted their children's interest in using the device improved when new games, taken from a list of suggestions made by the children, were added each week.

RQ#2(b) Value – Parent Theme: An Urgent Need for Help

When asked what parents observed from their children, the first parent commented, "He does not want camp to end, because then he has to give his iPod back." Another parent then asked, "How will this work this fall in school?" Interestingly, when seeking parental consent at the very beginning of the camp, it was made clear to every parent that a prototype was being used and there was a limited time for the study. When it was explained again that the software was only a prototype, the parent expressed disappointment saying, "This has helped her keep track of things better than anything else I have tried."

Several parents emphasized the urgent need for a method better than the paper planners typically used by their children. A parent commented, "I can't ever remember my son recording an assignment in a planner." Additionally, parents described paper planners being frequently lost and completely ineffective for tracking school assignments. One parent noted:

> Our son thought it was cooler to log his homework into an iPod than a planner, so much like, … he was very consistent and I did not have to ask him, but he was very consistent and I did not have to ask him, he would go write in his homework, log it in the iPod and put it away in his backpack, and that worked for him, far better than the planners that the school sends home that I cannot even use.

At the close of the second focus group, a parent asked, "So what happens after camp?" Once again the goal of using the data from the camp study to build a viable

technology for the future was explained. The parent responded, "Oh, so we have to have a plan B [this fall] for 7th grade, because we won't have this to help?" Interestingly, although parents were informed at the outset of the study that the device was a simple prototype with limited features and designed only for the study, they still asked if it could be used in the fall for school.

Summary for Research Question #2

The focus was to assess parents utilization of the iPod and their valuation of the iPod task list as a potential intervention. The quantitative results provide a descriptive view of the parents approach to utilizing the iPod with their children. The qualitative themes, excerpted from parent focus groups, include thoughts about the prototype device tested and a discussion of larger issues, such as the need for a more fully developed technology for organizing, planning, and task management. The proximal and distal perceptions are at times clear and also are a matter of interpretation. The results related to research question #2, with the constructs of utilize and value, are summarized in Table 9.

Table 9 Summary for Research Question #2 – Parents and Usability

| Construct | Results Related to Parents |
|---|---|
| a) Utilize | Parents completed the paper and pencil item verification checklist 88% of the time<br>34% percent of the parents reported using the iPod as a reward for DRC goal achievement<br>50% percent of parents reported allowing their children to use the iPod for free play time |
| (b) Value | Parent Theme: Parent-established contingencies help<br>Parent Theme: Reward value varies and depends on novelty<br>Parent Theme: We need it now: An urgent need for help |

## Research Question #3 Technology Features

What features of an early prototype do (a) children, and (b) parents value, what do they find unappealing and what features do they want incorporated into a more fully developed mobile technology?

### RQ#3(a) Features – Child Survey

Fifteen children completed the Features Survey. In this presentation of the results, the 5-point Likert scale was reduced to two categories – less important and more important. The category less important combined not at all important, a little important, and somewhat important, and more important included important and very important. It was assumed that endorsing a core feature during the usability test was in essence valuing a core aspect of the intended fully developed technology. This method of presenting the results was selected based on its utility for future design as compared to using means with a small sample size, or listing percentages under five different responses.

In Table 10 results are ranked from the question rated as most important to least important. Of the children, 87% rated item number 11, "All of my points are turned into minutes of game time on the iPod" as important, or very important. Three questions tied for the second highest ranked item; they were number 2, "I can wear my iPod on an armband or belt clip and carry it with me," with 80%; number 8, "I get points for game time from my teacher when I hand in an assignment," with 80%; and number 9, "I get extra points when I get a good score on an assignment," with 80%. These were rated as important or very important.

Table 10 Child Survey Results

| Child Features Survey ($n$ = 15) | Less important No. (%) | More important No. (%) |
|---|---|---|
| (11) All of my points are turned into minutes of game time. | 2 (13) | 13 (87) |
| (2) I can wear my iPod on an armband or belt clip and carry it. | 3 (20) | 12 (80) |
| (8) I get points for game time when I hand in an assignment. | 3 (20) | 12 (80) |
| (9) I get extra points when I get a good score on an assignment. | 4 (27) | 12 (80) |
| (5) iPod links to my teacher's computer so my assignment is right. | 4 (27) | 11 (73) |
| (10) Sometimes I get surprise points when I enter an assignment. | 4 (27) | 11 (73) |
| (7) I get points for game time when I enter an assignment right. | 5 (33) | 10 (67) |
| (4) I can have all of my classes (math, reading) listed on my iPod. | 6 (40) | 9 (60) |
| (6) I get a cartoon or animation when I enter something right. | 6 (40) | 9 (60) |
| (3) iPod reminds me with vibrations when I need to do something. | 7 (35) | 8 (53) |
| (1) The iPod checklist reminds me what to bring and take home. | 9 (60) | 6 (40) |

In contrast, the lowest ranked item was number 1, "The iPod has a checklist that reminds me what to bring and take home," with 40% of the children endorsing this as important or very important. The second to lowest endorsed items was number 3, "The iPod reminds me with alarms or vibrations when I need to do something," with 53% rating this as important and very important.

Interestingly, the highest ranked items relate to possessing the device and game play time. In contrast the lowest ranked items are those related to a task list for tracking assignments. As with research question #1 this may indicate the value children place on the device versus the value of a task tracking application. The child survey questions and percentage of responses divided into binary combined categories are shown in Table 10.

RQ#3(a) Features – Child Theme: Games Facilitate Use and success

At the outset of the second focus group, this author reminded the children the iPod task list program they were using was called a prototype, which was defined as an early version of a device being tested to see if it works. The vision for the impact model was reviewed, with the future software described helping children track tasks, maintain better links to their teachers, and receive game time rewards from parents for success.

The overall theme that emerged from the final six survey questions and engaging children in discussion was they valued the idea of the software being game-like. Before completing the survey questions, a very bright 12-year-old boy asked, "So, you were saying you would maybe make it into a game. Do you mean like if we do our homework it would do something to get you further along in a game, like it would be intertwined with a game, or like you would advance a level or something?" The author responded, "We did not talk about having levels and advancing, but this is a helpful idea."

After the children completed the survey the questions were reviewed as the starting point for a focus group. The children were asked what features they liked and what ideas they had for making the iPod tracking system better. In response to the statement, "You get points for game time when your teacher scores and enters your assignment," a child responded, "I think it would be important because when you did it [an assignment], it would be nice to have some game time, because where I was at in school, I got something [a reward for completing an assignment]." Another child commented, "I think if it was more game-like it would be fun, so maybe, like maybe each time someone does their checklist you could add a game to their iPod."

In addition to the children emphasizing they would like the technology to be game-like, parents also noticed the impact of the games on their children's behavior. During the parent focus groups one parent commented, "My son was the same. At first he wasn't that interested, but now that he has games he likes, he is using it [the iPod] more." Several parents commented that the games were highly motivating and they felt their child would cooperate with most any task as long as they received game time.

During the second parent focus group, the facilitator asked a question regarding a variety of possible motivations for children. A parent responded,

> It was the device that motivated him, he wanted the game time, and that was far more motivating to him then I will get you an ice cream, or better than hearing you are going to be in trouble if you do not do well, so the positive motivation was better than anything else.

RQ#3(b) Features – Parent Survey

The parent survey included a list of planned features for the fully developed software. Similar to the child survey, although a 5-point Likert scale was used to collect the data, based on an initial scan of the results, percentages were combined into two categories: (a) less important combining *not important, a little important, somewhat important* and (b) more important combining *important and very important*. In considering future product development, having rank-ordered categories is more useful than considering percentages in five different categories or using a mean value.

The parents most strongly supported items focused on children successfully managing tasks and items that strengthened links between home and school. For instance, 100% of the parents ranked the item, "Students will receive points for turning in assignments" as having high importance. Other items rated highly important included,

"iPod can prompt students with alarms or vibration when there is a need to remember tasks/items," and additionally the statement, "Parents will be able to view daily assignments on the website and on their mobile devices."

A second set of items rated as highly important were those focused on parent management. For example, "iPod will be limited to school-related functions during school hours," was ranked highly important by 88% of the parents. In addition, "Parents can access teacher communication/grades through website and smartphone," and additionally the statement, "Parents will determine what games, music, and entertainment may be loaded onto their child's iPod," were also rated highly important by 88% of the parents. Parents endorsing these items as highly important is consistent with the qualitative theme that emerged from parents regarding flexibility for parent management as described in the next section.

Interestingly, the feature that parents rated as the least important was, "Students can wear their iPods on an arm band or belt clip," with only 5 parents or 32% endorsing this as an important feature. The low level of importance attributed to this statement could be the result of awkward wording. Parents may have rated carrying the device higher in importance, if specific methods for wearing it had not been mentioned. Overall parents appeared to rank the items related to home-school communication and collorabation higher than items related to game time or play with the iPod. The parent survey questions ranked from the highest endorsed to the lowest are provided in Table 11 Parent Survey Results.

Table 11 Parent Survey Results

| Planned Features – Parent Survey ($n$ = 16) | Less important No. (%) | More important No. (%) |
|---|---|---|
| (12) Students will receive points for turning in assignments | 0 (0) | 16 (100) |
| (3) iPod can prompt students with alarms or vibration when there is a need to remember tasks/items | 1 (6) | 15 (94) |
| (11) Parents will be able to view daily assignments on the website and on their mobile devices | 1 (6) | 15 (94) |
| (16) iPod will be limited to school-related functions during school hours | 1 (6) | 15 (94) |
| (10) Parents can access teacher communication/grades through website and smartphone | 2 (12) | 14 (88) |
| (19) Parents will determine what games, music, and entertainment may be loaded onto their child's iPod | 2 (12) | 14 (88) |
| (6) iPod will have daily alarms as prompts before and after school | 3 (18) | 13 (82) |
| (7) iPod will generate a task list each day to remind child what to take and bring home | 3 (19) | 13(81) |
| (8) Students iPod will "sync" with the teacher's gradebook | 3 (19) | 13(81) |
| (2) Student iPods can be preloaded with their class schedule | 3 (19) | 13 (81) |
| (17) iPod will not turn on for gaming or music unless child has points to spend | 3 (19) | 13 (81) |
| (4) Tracking system will offer calendar with assignment dates | 4 (24) | 12 (76) |
| (9) Teachers will validate accurate assignment entry | 4 (25) | 12(75) |
| (15) Points will be converted into minutes of play time on the iPod | 3 (18) | 13 (74) |
| (5) Tracking system will give visual cues for due dates | 4 (26) | 12 (74) |
| (13) Students will receive additional points for assignment accuracy | 5 (31) | 11(69) |
| (14) Reward points will have intermittent "surprise" values | 5 (31) | 11 (69) |
| (18) iPod system will offer flexibility so other activities can be entered with point values assigned and earned | 5 (31) | 11 (69) |
| (20) The website will provide information, resources, educational articles, and FAQ's for parents | 10 (62) | 6 (38) |
| (1) Students can wear their iPods on an arm band or belt clip | 11 (68) | 5 (32) |

RQ#3(b) Features – Parent Theme: Feature Flexibility for Monitoring and Management

The final parent focus group started with a brief PowerPoint presentation reviewing future ideas for the technology. From the outset the theme of software flexibility for parent management emerged. One of the first comments from a parent was, "It would be nice to have the software on your PC or Mac at home, and then when you sync it [with the iPod] everything works together, because the computer is the same thing, they can go online and play games." This was confirmed as a feature of the software.

Another parent then commented, "Just a quick idea is that different kids will have different needs … and will it be possible to customize for each kid?" This was confirmed as part of the plan for the technology. A parent then commented it was important that parents control the actual amount of game time children receive. Other parents agreed, noting that time for electronic games varies; for example, in the summer children are allowed more game time. This was confirmed to be included as a feature in the fully developed software.

Following this discussion, a parent commented, "Just a thought about the software is if you have a set amount of game time per evening, but then if you have something come up on the weekend, maybe the child should have the choice of whether to save the time or use it." Another parent had additional questions relating to parental management of the amount of game time, and he asked, "As a parent will I be able to have a password to control when he gets it, and could I go in and change the amount of game time or things like that? You know could I go on and add additional time." The ability for

parents to manage access and amount of game time were confirmed as planned features for the future software.

The comments and questions continued as the parents interacted. One parent asked, "Do you think it would work to have rewards that include not playing on the iPod?" Another parent asked, "So what if you could create a menu of rewards, like so many points equals a trip to go play at the park or something?" The first parent responded, "Yes, like my daughter is not motivated at times to play the iPod, but I do not know if it would be a big motivator for her across the board, and especially not the whole school year." Yet another parent commented, "I like the idea that I could go in and enter other tasks, and then if I want give additional rewards." Overall many parents supported the idea that points could be used for rewards other than device game time.

A desire for the software to run on devices other than the iPod surfaced. For instance, one parent commented, "This may be a little bit ahead, but while were talking about the programming, will the program ever be able to be used on other devices, so that whatever smart phone you already own, could this be downloaded as an application?" This was confirmed as part of the long-term plan for the product. In summary, parents made numerous comments related to the flexibility of the final software, so they could adjust the application to fit their family rules, routines, and their child's specific needs.

Related to question # 3 children rated features linked to earning game time highly important and desired the application to be game-like. The highest rated items by the parents were related to managing tasks and linking home and school. The quantitative and qualitative results regarding desired features rated by parents and children are included in Table 12.

Table 12 Summary for Research Question #3 – Technology Features

| Construct | Results Related to Children and Parents |
|---|---|
| (a) Children: Desired Features | All of my points are turned into minutes of game time on the iPod 13 or 87%<br>I can wear my iPod on an armband or belt clip and carry it with me. 12 or 80%<br>I get points for game time from my teacher when I hand in an assignment 12 or 80%<br><br>Theme: Being game-like motivates use and facilitates success |
| (b) Parents: Desired Features | Students receive points for turning in assignments 16 or 100%<br>iPod can prompt students with alarms or vibration when there is a need to remember tasks/items 15 or 94%<br>Parents will be able to view daily assignments on the website and on their mobile devices 15 or 94%<br><br>Theme: Feature flexibility for monitoring and management |

## Chapter Summary

The results by research questions suggest that children will utilize the device for task tracking in a structured setting, will potentially improve task completion when the device is used as a contingent reward, and value the ability to carry the device. Furthermore, children want the actual application to be game-like and value rewards for successful task completion. In addition, the results suggest that parents will also utilize the device, support the design concept, and endorse many of the planned features. Chapter 6 provides a discussion of these results in terms of answering the research questions, relevance for product design, and organizational skills research.

# CHAPTER 6

# DISCUSSION

This chapter begins with a discussion of the results by research question. These results are then compared to previous research related to organizational skills interventions for children with ADHD and HFASD. The discussion includes a description of the potential uses of the prototype and, more importantly, how the fully developed technology may integrate or expand upon current interventions. The strengths and limitations of the study are presented. This is followed by a discussion of the implications of the study for social work research, policy, and practice. The chapter concludes with recommendations for further development of the mobile technology as an organizational skills intervention for children with ADHD and HFASD, and an appeal for an increased presence of social work in technology design and development research.

## Discussion of Results by Research Question

The present study focused on the usability of a prototype mobile technology intended to assist children with ADHD and HFASD with organizational skills. Usability of a product is typically defined by the product meeting goals related to effectiveness, efficiency, and satisfaction (ISO, 1998). An additional aim of the study was to generate ideas for future product design, a common goal of formative usability testing (Rubin &

Chisnell, 2008). In addition, an overarching aim of the study was to assess proof of concept (POC) for feasibility of further product design .

In the discussion that follows the results are integrated consistent with Jick's (1979) discussion of *triangulation in action*. Chapter 3 Methods, and Chapter 4 Results, moved toward triangulation by bringing together qualitative and quantitative data sources for each research question. Triangulation may be viewed somewhat superficially as a means to strengthen the validity and credibility of results. However, a more important purpose of triangulation in action is that it helps the researcher synthesize complex data and leads to more holistic thinking (Jick, 1979). This approach to triangulation was articulated by Barusch, Gringeri, and George (2011) who described the purpose of triangulation as, "to deepen understanding by collecting a variety of data on the same topic or problem with the aim of combining multiple views or perspectives and producing a stronger account rather than simply achieving consensus or corroboration" (p. 13). In the following discussion, synthesizing the qualitative and quantitative results creates a more holistic and stronger account in connection with the research questions and purpose of this study.

Research Question #1: Children's Utilization, Valuing, and Improving Task Completion

The first research question focused on the extent to which children would utilize and value the prototype, and whether utilization would improve task completion. The utilization results were remarkable. During the usability test days children nearly always brought their iPods to camp, and they seldom lost or forgot them. In addition, they

consistently completed the task list. This finding may seem simple and intuitive; however, it is important to remember that many of the children had quite severe difficulties with organizational skills, oppositional behavior, ADHD and HFASD. These results suggest that children will utilize the technology in a structured setting.

Although the results showed a high level of use, it was not possible to determine what factors lead to these high rates. Children received a small number of camp points for bringing the device each day and for completing the task list. These points were essentially a point of performance reward for using the device as planned. Although the reward was a bit more delayed, the children also knew that they would receive 20 to 30 minutes of game time if they brought the device each morning. This provides additional support for the premise that children valued the opportunity to carry the device and they were motivated by game time. In addition, the results showed that parents assisted their children by helping them check for required items and complete the task list each morning. The most basic and perhaps important result related to this research study was that children wanted to carry and utilize the device, and parents were actively involved in helping them use the device as intended.

However, there were times when the children did not bring the device to camp or forgot to complete the task list. Although this occurrence was fairly low, the reasons given were typical of children with ADHD and HFASD. Often the reasons given were that the device was lost or forgotten at home or left in the car on the way to camp. The consequences for losing the device were not earning the small number of camp points associated with bringing the device, and the logical consequence of missing game play time. Despite the low rate of forgetting or losing the device, the ongoing issue of

forgetting to complete the task list or losing items will need to be addressed in future design. In the zeal to create a beneficial technology the ongoing issue of inattention – losing, forgetting, failing to use – could be overlooked. This issue will be one of ongoing concern in the development of a robust technology.

On a few occasions, children described pro forma completion of the task list right before arriving at camp or at the end of the day before going home. Based on the author's observations during 30 years of working with children, such hoop-jumping is not an uncommon approach to task completion. To address this issue the final product will need to include a system for decreasing the likelihood of pro forma task completion. The current design plan includes having parents and teachers verify actual task completion.

The homework return trial provided an initial assessment of the extent to which the prototype would help improve task completion. A primary aim of the study was to assess utilization of the device as related to feasibility, a *first order* evaluation concern (Oulasvirta, 2012). However, the homework completion trial also served as an initial attempt to measure the impact on the users, a *second order* evaluation concern in usability testing (Oulasvirta, 2012).

During period 2, when the device and task list were introduced and used without a contingency, there was an increase of more than two times the likelihood that homework was completed. This suggests that the saliency of carrying the device, or having the task list, or perhaps an assumed contingency with keeping the device, improved the rate of homework completion. During period 3, when game time was made contingent upon completing the task list and having homework returned, there was four times the likelihood that homework was completed.

The results suggest that the device was more effective when directly used as a contingent reward for completing a task. Importantly, although the likelihood of homework return increased during both periods where it was used, without a control group and a research design that increases internal validity the results may show an association, but it is not possible to infer causation.

Overall, the homework completion results suggest that possessing the device increases the salience for completing a planned task when there is a direct contingency between use of the device and successful task completion. This finding is consistent with the principles of reinforcement from applied behavioral analysis (Kearney, 2007). The importance related to this usability test was the tentative finding that the iPod and use of the task list hold potential for serving as an organizational skills intervention with a high reward value.

Importantly, the future technology design includes incremental rewards for each step of task completion. This may strengthen or sustain the impact of the device, as it will mean that children earn point of performance rewards for various steps along the way to task completion. In testing a future more fully developed product, second order questions relating to effectiveness of the device on performance will need to be addressed. In addition, the children's qualitative responses suggest they value possessing the device first and utilizing the task list second. For instance, when the children described the task list, they often linked using it to the reward of game time.

The children's survey was primarily directed at evaluating features; however, the results may apply to valuing as well. Children rated carrying the device and receiving game time rewards as high in importance and the items related to using the task list as

low in importance. Most parents would perhaps describe this finding as obvious since most children are much more interested in playing games on electronic devices than they are in doing demanding tasks such as homework or chores. However, in future product development it will be important to recognize the high value that children place on carrying the device and playing games. The final product may be more effective if it is game-like and there is a direct focus in design on enhancing its reward value. Related to this, the children asked for game-like levels for advancement, and several asked to have "surprises" for successful task completion.

Overall, the quantitative data from the daily log, the homework completion trial, and the qualitative themes from the children suggest that the technology is feasible using fairly relaxed definitions of effectiveness and satisfaction appropriate to the prototype. In addition, the technology was efficient as defined by actual time for use, and use without complaints, resistance, or refusals because of time or effort required. All of these findings must be qualified as occurring in this specific usability test. An important consideration in scaling up the application is that increased complexity may impact all three fundamental aspects of usability – effectiveness, efficiency, and satisfaction. In conclusion, the results from testing with children lend credence to the assertion that there is proof of concept for further development of the technology.

Although very tentative due to this early prototype, using the terminology from Barkley (2002), the device in a more fully developed version may hold potential to serve as a *motivational prosthesis* for children with ADHD and HFASD to improve their ability to focus and successfully complete tasks. In addition, game time appears to work well as a *point of performance* reward for successful task completion.

Research Question #2: Parents Utilizing and Valuing

The second research question focused on the extent to which parents would utilize and value the technology. The daily parent logs revealed that parents did utilize the technology with their children. The logs also served as a paper prototype for Internet capability. Parents used the logs to check off whether or not their children brought home required items. Although these results were promising, parent use and valuing of Internet links and functions need to be examined in future studies.

Importantly, the parents consistently used the device as a contingent reward for both camp-related tasks and other home-related expectations. When parents used the iPod as a reward for successful completion of camp DRC goals, they typically reported that their children's motivation increased. This suggests that the technology holds potential for creating home and school contingencies for task completion. In addition, the daily parent log was a method of simulating home-school communication because the child's goal completion was communicated to the parent each afternoon. Parents recorded use of the device as a reward, and reported this information daily. This basic modeling of home-school communication can be further digitized in future product design.

A theme that emerged from the parent focus groups was that the reward value of the device varies, with an ongoing need for novelty. The parents described their children as not being particularly interested if the games were not exciting. The need for novelty is a common theme for motivating children with ADHD (Zentall, 2005). After children were allowed to list games they liked and some of these were uploaded, parents reported that their children were motivated to play with their iPods. This suggests that methods for creating novelty will be needed in future design.

A final theme that emerged from the parent focus groups was the sense of urgency for getting help with organizing, planning, and managing tasks related to children's schoolwork. The parents described the challenges with paper-based planners for helping their children complete homework and other school-related tasks. Research shows that parents of children with ADHD have a lower sense of self-efficacy for helping their children with school and feel less welcomed and supported by schools and teachers than parent's of children without ADHD (Rogers, Wiener, Marton, & Tannock, 2009). This sense of urgency may be related to the parents diminished sense of self-efficacy and general feelings of lack of support from the schools. This is consistent with the clinical observations of the author spanning many years of working with parents of children with ADHD. The parents' sense of urgency for a more fully developed product was quite strongly linked to their perceptions of the ineffectiveness of the typical paper planner method of home-school communication.

In summary, the parents participated in using the device for task tracking, as a reward for task completion, and valued the potential of having a mobile technology to help their children with organizational skills, in particular with home-school communication and homework completion. In terms of evaluating usability, the results from parents suggest that the prototype was effective if measured by utilization, efficient if defined by completing the tasks without complaint as to time and effort, and satisfying as indicated by subjective report of valuing the features and potential of the technology. In addition, the goal of this study was to assess the prototype in order to validate the feasibility for the design and development of a more fully developed technology. The

parents' participation in actual use and qualitative responses also suggest proof of concept for the feasibility of further development of the technology.

Research Question #3: Features That Parents and Children Value

The third research question focused on assessing the desirability of the current features and gaining ideas for the future product design. Themes that emerged from the focus groups and surveys with children included their desire for the future product to be game-like, linked to their teacher, and include rewards for task completion. The children did not have many ideas for future development. This lack of additional ideas may be related to several factors. First, the focus groups were brief and there was not sufficient time to explore future possibilities for technology design. Second, it was difficult for both parents and children to generate new ideas during this early prototype trial. Perhaps a more effective method for generating future ideas would be to have children and parents serve as design partners during the testing of ongoing product iterations. The limitation of digital prototypes for generating new design ideas was noted by Arnowitz, Arent, and Berger (2007).

The parents valued many of the planned features as shown by their responses to the parent survey. In addition, the parents provided a number of ideas for future development in their focus group responses. A key theme that emerged from the parents was their desire for more product flexibility. For instance, the parents wanted the product to have flexibility for tracking home-related tasks as well as school-related tasks. Additionally, the parents wanted the future product to allow for assignment of point values to various types of rewards other than game time on the device.

The survey responses from children and parents included in Chapter 5 are ranked from most, to least, important. In the future these prioritized responses may be helpful for keeping what parents and children value at the forefront of future design and development.

## Findings in Relation to Previous Research

The present study relates to previous research as it demonstrated that mobile technology can be used to integrate multiple aspects of current empirically supported interventions. In the following paragraphs the results of the present study will be compared with the most recent studies of organizational skills interventions for children with ADHD. As described in Chapter 2, there are few studies of organizational skills interventions with children with HFASD, and those that do exist are limited in terms of providing details and rigor in design. Therefore, the following two comparison studies are focused on ADHD. At a conceptual level the findings from these studies likely relate to children with HFASD as well, as it too is a long-term neurodevelopmental disorder.

The first comparison study is a recent large-scale randomized clinical trial by Abikoff and colleagues (2013) who demonstrated that both skills-based training methods and performance-based approaches significantly help children with ADHD reduce organizational skills deficits. Abikoff and colleagues (2013) concluded that future interventions may provide the greatest benefit if they include both an organizational skills component and performance-based rewards.

The prototype tested in the present study was an initial design, but it provided a basic means of integrating an organizational skills component with performance-based

rewards. The task list was used to track items – an organizational skill – and the camp points and game time provided a performance-based reward.

Notably, the proposed technology will be centered on a calendar that will include tasks and prompts for organizing, planning, and task management. The planned technology will essentially model a skills-based approach, and it will allow parents to provide point of performance rewards for successful task completion. A fully developed technology will in essence combine digital modeling of organizational skills with performance-based rewards.

A limitation of the Abikoff and colleagues (2013) study was that the interventions were not sustained. The children in the Abikoff (2013) study were taught organizational skills, they learned and implemented them, and they were followed for a year. They made significant gains. However, no long-term methods for prompting utilization or for sustaining the interventions were described. In addition, some drift toward baseline functioning was demonstrated during the follow-up period (Abikoff et al., 2013). In the present study drift toward baseline occurred during the intervention withdrawal period of the homework completion trial. A fully developed mobile technology will have the capacity to sustain both the organizational skills and performance-based intervention for as long as they are needed.

The results from Abikoff and colleagues (2013) included a reduction in conflict with teachers and parents and improvement in grades. Although the results of this usability test did not quantitatively demonstrate reduced conflict with parents, the parents' focus group responses included statements that indicated reductions in their children's complaints and resistance toward completing homework.

This suggests that a fully developed application may increase successful task completion and remove some of the negative encounters parents have with children over failure to complete homework or other tasks. In addition, although it was not possible to demonstrate improvement in grades, rates of homework completion significantly increased when the device was used, and completion of homework is a component of improved academic achievement (Cooper, Robinson, & Patall, 2006).

The second comparison study is a school-based organizational skills intervention as reported by Langberg and colleagues (2011b). This study included holding focus groups with school mental health staff to evaluate the intervention. Themes that emerged from the focus groups included that: (a) rewards were highly motivating but excessively delayed; (b) more flexibility was needed; (c) teachers needed to be more involved, an unobtrusive method was needed for verifying accurate recording of assignments in the planner; (d) a tracking system was needed for monitoring missing assignments; (e) additional parent involvement was needed; and (f) methods were needed to increase student ownership of the intervention.

The prototype was as an initial iteration of a vision for a more robust mobile technology. At the conceptual level the prototype, and by extrapolation the fully developed technology, remedies a number of the deficits identified by the focus groups in Langberg and colleagues (2011). For example, in the present study rewards were given nearer to the point of performance than after school, and the classroom teacher was involved in giving a homework assignment for entry and tracking. In addition, an unobtrusive method for verifying the accuracy and completeness of assignments was utilized. This will be incorporated in the future technology by syncing the device with the

teachers' learning management system via Internet technology. Finally, an important result in this study was that the children self-managed the device for task tracking, and they appeared to take ownership by bringing the device to and from camp each day.

As described in Chapter 1, Barkley (2002) suggested that a key problem with the current psychosocial interventions for ADHD was that they do not account for the long-term neurodevelopmental deficits that come with the disorder. Based on the author's observations, this same issue of a lack of sustained interventions also applies to children with HFASD. The vision for the impact model includes building a technology that will serve as sustained intervention for children with both ADHD and HFASD for as long as the support is needed.

Miller (2012) emphasized that a crucial area for future research was to assess ADHD treatments for maintenance of gains. This study was brief and it was not possible to assess maintenance of gains. However, a strength of using mobile technology as an intervention is the ability to assess use and maintenance of gains as an ongoing activity. The ability to assess gains by gathering data through the Internet is a planned feature for future design.

## Strengths and Limitations

### Strengths

Saleeby (2000) emphasized that from micro to macro levels, the starting point for social work practice ought to be empowering clients by identifying and validating strengths before addressing barriers and constraints. Consistent with this approach, the strengths of this study will be presented before describing the limitations.

In scholarship related to formative usability testing, authors have proposed various models and concepts for quality that include and transcend traditional reliability and validity metrics. In general, traditional internal and external validity concepts may be more appropriate to summative usability testing than formative testing (Bastien & Scapin, 1995). In addition to the limitations of traditional quantitative validity criteria for formative usability testing, the standard validity criteria for qualitative research – credibility, dependability, confirmability – all leading to trustworthiness (Guba & Lincoln, 1994) also have limitations as validity metrics for formative usability tests. The primary limitation with traditional quantitative and qualitative validity metrics is that they are focused on the research process instead of the outcome. In contrast, the primary goal of formative usability testing is to assess and inform an outcome – further product design (Lewis, 2006).

A creative alternative to using only traditional validity metrics for assessing formative usability tests was proposed by Farrelly (2009). He suggested that quality metrics for formative usability evaluations include the test being *appropriate, meaningful*, and *insightful* for further product design. These metrics will be further defined and applied to evaluate the strengths of the present study. In discussing the appropriateness of usability tests, Farrelly (2009) did not throw out the traditional concepts of internal and external validity, but emphasized that the goal of formative usability testing was to appropriately address the needs and constraints of a specific design situation and product.

An initial issue related to appropriateness is sample size. As discussed in Chapter 3, this has been a matter of longstanding debate in the usability testing literature. Using a

mathematical algorithm, Nielsen (2006) argued that 70% of design problems could be identified by testing with 5 users. Others have argued that if a product serves a homogenous group, then testing with three or four users may be enough (Caulton, 2001).

A strength of this study was having an appropriate, and indeed robust, sample size for a formative test. By including 16 children and 16 parents a large amount of qualitative and quantitative data were collected providing a broad range of perspectives related to usability. The sample size increased the credibility of both the quantitative descriptive and the qualitative thematic findings.

A second quality metric suggested by Farrelly (2009) was appropriate participant selection. Random sampling and stratified sampling are not realistic for formative usability testing; therefore, testing is typically done with convenience and purposive samples. Rubin and Chisnell (2008) suggested that the best criteria for participant selection may be how well the participants represent actual users.

A strength of this study was the participants represent the actual intended users of the fully developed technology. In addition, in some cases participants are not adequately assessed for fit with the purpose of a usability test or with the product being tested (Nielsen, 1992). The screening instruments used in this study provided reasonable evidence as to the severity of ADHD, HFASD, and the organizational skills deficits of the participants.

A third area of appropriateness identified by Farrelly (2009) was task selection. The number of possible tasks to evaluate in any given test is limitless. Lindgaard (2006) suggested that researchers learn about users context, and then select tasks that are central and critical. A strength of this study was that the literature review and clinical expertise

of the author and primary investigator were combined to select appropriate tasks. For example, the literature on organizational skills strongly supports that homework completion is a key organizational task that is challenging for children with ADHD and HFASD (Bryan, Burstein, & Bryan, 2001; Power, Werba, Watkins, Angelucci, & Eiraldi, 2006). Based on this knowledge, homework completion was selected as the primary task to assess effectiveness via binary task completion.

A fourth area suggested by Farrelly (2009) was the appropriateness of usability measures. Regardless of the basic constructs defining usability, and the many methods for assessing usability, there is not a common set of metrics for what constitutes a usable product. In addition, the historic approach of treating measures as similar to dependent variables in social science studies is not particularly useful for evaluating product designs (Cockton, 2008).

Consistent with this premise, Hornbaek (2006) commented, "What we mean by the term usability is to a large extent determined by how we measure it" (p. 79). After reviewing 180 studies and a multitude of approaches to measuring effectiveness, efficiency, and satisfaction, Hornbaek (2006) emphasized that the design context, goals of the project, and needs of users provided the best guidance for selecting and/or designing measures. In addition, he noted that measuring macro tasks that are socially and cognitively complex, using domain experts to assess quality of interaction, and directly measuring outcomes versus only using utilization data to support effectiveness were important for future research (Hornbaek, 2006).

Therefore, a fourth strength of this study was the appropriateness and relevance of measures. Using social science language; the STP setting, the iPod task list, and the other

data sources provided a fairly ecological valid setting, technology, and measures for the types of routines and tasks that children typically complete. In addition, the logs, homework completion, and qualitative data were appropriate measures for assessing effectiveness, efficiency and satisfaction (valuing).

A second major quality metric for formative usability tests that Farrelly (2009) proposed was whether or not the results were meaningful. The typical quantitative methods for ascertaining meaningfulness are statistical significance and effect sizes. These have applicability to usability tests, although they may be particularly useful for summative tests (Bastien & Scapin, 1995). Some scholars have argued for quantitative data-driven approaches to identify and prioritize meaningful problems in all usability studies (Lewis, 2006). On the other hand, others have emphasized that identifying and prioritizing problems is best done as an interpretive process within a hermeneutic community of testers and designers (Greenburg & Buxton, 2008).

A fifth strength of this study was that the meaningfulness of the findings and prioritizing of needs and features occurred through both data-driven and interpretive methods. The surveys provided a quantitative picture of prioritized needs based on user preferences. The qualitative responses were helpful for identifying themes and needs that were important and meaningful to the users.

The final area for a quality metric proposed by Farrelly (2009) was the extent to which formative usability testing research generates insight. Insight includes increased knowledge about users, and rich information regarding user experience that is helpful for building a product that meets user needs (Farrelly, 2009). The primary approach to gain insight emphasized by a number of usability scholars is use of a prototype or direct

product usage with observation of user behavior and interaction. The goal of this approach is to gain depth of insight into users' needs (Genov, Keavney, & Zazelenchuk, 2009; Nielsen, 1992; Wixon, 2003).

Therefore, a sixth strength of the present study was that it was designed as a field-test and included direct interaction with children and parents thus providing insight into their experience and needs. This approach to usability testing led to insight as to the ways in which children used, and didn't use, the prototype; as well as insight as to what was most important to children related to future design. In addition, the approach provided insight related to what the parents valued and desired in a more fully-developed product.

A final strength of the study involved the effort made to align the purposes and practices of evaluation research with the purposes and practices of design (Cockton, 2008). In a statement intended to integrate these purposes, Cockton (2008) emphasized that for future usability testing the ultimate desired outcome was "to create value in the world through innovative products and services" (p. 287). The present study used the practice of evaluation methods in order to inform the design of an innovative product intended to create value by helping children with ADHD and HFASD.

## Limitations

The limitations of the present study fall under the traditional external and internal validity concepts of quantitative research, the traditional trustworthiness criteria for qualitative research, as well as other practical issues of limitation. The limitations are described in the following paragraphs.

One limitation was the inability to determine the relative effectiveness of the task list as compared to the overall reward value of having an iPod. The iPod was designed to attract children as consumers, and consequently, children's valuing the ability to carry an iPod and earn game time as a reward are ubiquitous. The iPod and many games are highly developed technologies, but the task list was a simple prototype of a technology concept. Therefore, the task list may have held minor value as compared to the reward of possessing and carrying an iPod for several weeks. The impact of each is unknown, but intuition suggests the iPod and game time were the primary motivators.

It is important to note, however, that in their qualitative responses both the children and their parents supported the idea of the task list, despite the draw of the iPod and game time. The parents, in particular, were enthused by the possibility of having a consistent method for managing and monitoring tasks that was integrated with a device that has a high reward value.

A second limitation of the present study was the lack of a comparison group for the homework completion trial. The results were remarkable in terms of the fourfold increase in the likelihood that homework was completed when using the device as a reward. However, without a comparison group or control group there are alternative explanations for the that change cannot be ruled out. For example, the children's rate of homework completion may have improved as camp progressed without the intervention, and parent and child awareness of the parameters of the study may have influenced the rate of return. Although there was an association between the iPod use and the increase in homework return, the lack of internal validity precludes inferring causation.

A third limitation of the present study was the inability to distinguish differences in utilization, valuing, and impact between children with ADHD and HFASD. The study design involved using brief screening instruments for identifying children with ADHD and HFASD; and the study was not designed to differentiate interest or impact by disorder. Differences in organizational skills deficits between children with ADHD and HFASD were not assessed, and the degree of utilization, effect on homework completion, and satisfaction were not differentiated by ADHD and HFASD. Assessing differential impact is more appropriate for future research in a clinical trial with more participants.

A fourth limitation was the relatively small number of participants. If the purpose of the study was to test a robust intervention the sample size could be considered as quite limiting; however, the primary purpose of the study was to test an early design concept and gather utilization data. Therefore, the number of users may be considered appropriate, if not larger than the number of participants in many usability tests (Caulton, 2001; Nielsen, 2006).

Additional study limitations included: (a) homework completion was the only variable targeted to measure effectiveness at the level of behavior change; (b) the time for testing was brief; and (c) the testing occurred in a unique treatment setting. The STP was highly structured and included a process for checking in each day, and it included a contingency management system for behavioral intervention. Therefore, that children regularly completed the task list could be explained by the unique structure and behavioral treatment process of the STP. This is an issue of ecological validity where the camp may not be comparable to a regular home or school setting.

The camp lasted 8 weeks with the iPod trial lasting approximately 4 days a week for 4 weeks. This was a very brief time period for testing usability. The possibility exists that the reward value of the iPod could drop significantly over time. Parents and teachers often encounter the problem of worn out reinforcers (Graziano, 2008) when working with children with ADHD. The problem of worn out reinforcers could be addressed by sustaining testing over a longer period of time (e.g., a school year).

An additional limitation of the study may be expectation effects of the participants. The parents and children were informed of the purposes of the study at the outset. As a result their behavior may have been influenced as they knew they were participants in the study. Knowing the purposes and goals of the study may have increased their cooperation with multiple aims of the study, and thus rendered a condition where they answered questions in a socially desirable manner to help the study succeed.

In addition, the author's bias may have impacted the study. The author designed the data collection instruments, collected the data, interacted with the parents and children, and analyzed and reported the data. All of these factors may have influenced the results even though the author was committed to maintaining neutrality and conducting the study without introducing bias. With regard to bias, usability scholars have questioned the impact that evaluators have on usability tests in terms of design, findings, and reporting of outcomes (Hertzum & Jacobsen, 2001).

Finally, a limitation of the present study was that it was more beneficial for assessing and validating the overall concept than for generating new ideas for technology design. The multiple data sources showed utilization, impact, and valuing of the planned

features, but limited information was generated for future design. This is understandable since the study was an early formative test of a prototype with limited features.

## Implications for Social Work Research, Policy, and Practice

The present study has a number of implications for social work research. First, it demonstrated the potential for social work to have a place at the table in technology design research. A significant change associated with the digital age is that an increasing number of products are now being designed to improve human health and wellbeing (Stinson, Wilson, Gill, Yamada, & Holt, 2009). The focus on designing products to improve human wellbeing is consistent with the focus of social work, and the goal of designing products to improve human wellbeing provides an incentive for social work to participate in design research.

Second, current design methods emphasize the relational aspects of humans and technology. An important statement related to the purposes of usability testing came from Rubin and Chisnell (2008) who stated that designers "lose touch with the fact that they are not designing products per se, but rather are designing the *relationship* of product and human" (p. 11). Social work specializes in researching, understanding, and developing relationships. A theme in the design literature is that information science engineers are often skilled at the technical aspects of design, but they struggle with the human relationship aspects of research (Robertson, 2005; Wagner & Piccoli, 2007). In addition, lack of understanding and integrating end-user needs and desires is a key factor leading to product failure (Rubin & Chisnell, 2008).

Social work researchers have the ability to assess the needs and interests of end users because social work is a profession grounded in understanding human behavior and creating collaborative relationships. Interestingly, we live in a world in which we experience collaborative (user friendly) or noncollaborative relationships with technology. Social work researchers have the capability to assess and facilitate relationships between humans; and in collaboration with designers, social workers also have the ability to assess and facilitate relationships between humans and technology.

Third, social workers know how to effectively relate to various client groups who may be the recipients of a technology-based product. For example, in the present study the methods of relating to children with ADHD and HFASD and their parents were based on 30 years of social work practice. Regardless of the technical aspects of the research method, it was the use of direct practice skills that led to knowing how to connect with children and parents and to gather information unobtrusively. The need for relationship skills is emphasized in the emerging field of child computer interaction (CCI) that blends design research methods with the skills to engage children as participants (Druin, 2002). Social workers have the ability to facilitate user centered design based on our client centered practice skills.

Fourth, social work researchers are comfortable with quantitative and qualitative methods, are able to embrace ambiguity, and accept probabilistic knowing. Engineers may approach research design and methods from a linear (one best solution) mindset (Hornbæk, 2010). In addition, software designers often have limited coursework and knowledge in research and statistical methods (Curtis, 2009). Social work researchers are comfortable with fitting research designs to human contexts and working with complex

probabilistic results for understanding and addressing problems. This flexible approach to research design and methods that is practiced in social work is now being emphasized in the software engineering literature (Sommerville, 2005). Social work researchers are able to balance rigorous and systematic approaches to research with the flexibility and creativity that is appropriate for studying human behavior and designing interventions.

Fifth, social workers typically conduct research based on "want-to-do-ability" (Marshall & Rossman, 2010, p. 11). This typically comes from a passion to improve some human condition. Social workers are persistent and tenacious in their efforts to develop solutions to relieve human suffering and build a better world. The mindset that is at the heart of social work leads to focused, disciplined, and determined efforts in research and practice. This same passion and commitment is needed to nurture a product through the challenging design and development process.

Sixth, the present study demonstrated that social work research and practice skills can be blended with design research skills. Social work practice skills are easily translatable to become design skills. In addition, the theoretical and technical aspects of shifting a research focus from a general social science paradigm, intended to generate theory or build knowledge, to a design paradigm focused on real-world actualization of a product are more about changes in focus and purpose than research methods and skills. Moving to design research requires a greater change in the approach to qualitative research versus quantitative, especially since qualitative research often becomes bogged down in debates over epistemological and ontological frames (Denzin, 2012).

In both social science and design research paradigms, quantitative research is targeted to gather data directly related to research questions or to confirm hypotheses.

However, in social science, qualitative research tends to start with a lengthy articulation of a research paradigm from a more goal-free position. This does not fit well with design research, in which a product (a design) is visualized from the outset.

In the present study, the general inductive approach as outlined by Thomas (2006) provided an excellent method for adapting a qualitative research method to design research as it is grounded in a critical realist frame and it balances relatively goal-free analysis with a more structured focus on addressing research objectives.

Seventh, social workers are comfortable with flexibly moving from research and theory to application and practice in a back and forth manner. The usability testing literature is replete with literature that examines the uncertainty and dilemmas that exist between usability testing research and the impact on product design. Social workers are comfortable with viewing theories as heuristics and research knowledge as partial, but in practice are able to readily engage their next client within the context of limited knowledge. Similarly, in usability testing, inevitably the next product will be designed regardless of the theory and research limitation dilemmas. Social workers ability to comfortably bridge the research and practice gap may be helpful for bridging the usability testing and product development gap.

The implications of the present study for social work policy are perhaps somewhat latent until a more fully developed product is available for testing and use in a school setting. If a product was ready for testing in a school setting, a social work role might be to advocate for its use as an assistive technology. The present study demonstrated the potential for an assistive technology to benefit children with organizational skills deficits. At a broader level, social workers need to build awareness

of a range of technologies that may serve to improve human conditions, and advocate when digital technologies are not provided to those with identified needs.

Social work education includes teaching students advocacy skills for helping marginalized groups. The current emphasis in teaching advocacy is focused on psychosocial interventions and policy. Although technological solutions for human problems are in an early stage of development, social work education needs to include a greater emphasis on advocating for technology to support marginalized groups and populations.

There is an emerging body of literature in the HCI field related to culture, disabilities, and the usability of digital products (Hertzum, 2010; Newell, 2011). In addition, HCI scholars have emphasized that a priority for future research and design is to increase mobile technology accessibility by marginalized populations (Coursaris & Kim, 2011). These concerns are consistent with the mission and values of social work, and social work scholars can substantially contribute to both the conversation and actions taken to empower disadvantaged populations in gaining access to digital technologies.

The present study implies that social workers develop comfort and competence in using a variety of digital technologies for intervention. In all likelihood, this is happening as current social work students are growing up in a digital world. However, gaining awareness of technology-based interventions needs to become a part of social work education in the same way that students currently build knowledge of psychosocial interventions.

Berzin and O'Connor (2010) emphasized that social workers need to increase their knowledge related to children with ADHD and HFASD, and noted that these topics

were insufficiently covered in social work education. In all likelihood very few social workers possess a depth of understanding of the deficits that children with ADHD and HFASD have with organizational skills, the long-term consequences of these deficits, and research related to interventions. The present study offers an additional resource for understanding these issues.

In conclusion, social work must increase its focus on research, practice, and policy activities related to technology. Recently terminology has emerged in the social sciences that describes the use of information technologies designed to address behavioral health outcomes as; (a) *ecological momentary interventions* (Heron & Smyth, 2010), and (b) *behavioral intervention technologies* (Mohr, Burns, Schueller, Clarke, & Klinkman, 2013a). The phrase ecological momentary interventions provides a description of how technologies may be used in a natural environment in periodic moments; however, the terminology is cumbersome. The term behavioral intervention technologies (BITs) is now used to describe information or communication technologies designed to address behavioral or mental health conditions. This term seems more fitting for describing this emerging field.

The concept of BITs includes providing psychosocial interventions via videoconferencing, teleconferencing, instant messaging, web-based interventions, mobile technologies, social media, virtual reality simulations, and gaming. There are currently an estimated 97,000 mobile health applications, with most of these having little or no evidence for effectiveness (Mohr et al., 2013a). Social workers have the opportunity and obligation to investigate the utility of some of these applications.

A National Institute of Mental Health (NIMH) panel of experts recently reviewed the need and recommendations for further BITs research. The final report noted that mobile technologies have received little attention in terms of evaluation for efficacy and utility. Indeed, BITs generally are brought to market and provided to clients in clinical settings with little or no evaluation. There have been some trials of mobile technologies for a variety of mental health concerns, but research is in an early developmental stage, with virtually no discussion of how to efficiently and effectively evaluate mobile technologies (Mohr et al., 2013b).

The NIMH panel concluded that further research was needed to achieve new design, development, and evaluation models for BITs. In addition, behavioral science and other disciplines need to gain further understanding and integrate processes of user-centered design and usability testing into the development of BITs. The report noted that human factors and human-centered computing have developed methodologies for design and usability testing that could be adapted to BITs research (Mohr et al., 2013b).

The present study integrated concepts from usability testing, user-centered design, and social work research to inform the design of an emerging BIT. Social workers have actively participated in research to develop and validate empirically supported psychosocial interventions. The time has come for social workers to participate in research efforts to develop and empirically validate technological interventions.

In conclusion, social work must increasingly embrace technology as a field of practice. One possible approach suggested by Parker-Oliver and Demiris (2006) was to develop a subspecialty of social work informatics. However, rather than develop a specialty in informatics, it may be more beneficial if social work increases its

collaboration with relevant fields such as software engineering and human computer interaction. Mohr and colleagues (2013b) pointed out that the lack of collaboration in developing BITs has created a gap on both sides—software designers are developing BITs without the benefit of social and behavioral science knowledge, and social science researchers are developing BITs without relying on proven practices in human computer interaction and software design.

There is a need for deliberate efforts to integrate social sciences knowledge with technology design methods (Schueller, Munoz, & Mohr, 2013). The present study was an initial effort to integrate software design concepts and approaches with social work methods. This type of integration with collaboration is a key recommendation for social work to stay current and have relevance in a world that is increasingly shaped by digital technology.

## Future Development of the Technology

The following recommendations for future research focus on the development of the proposed technology. First, the product requires scaling up for testing in a school setting, by incorporating the planned features validated in this study, and by building actual Internet links between home and school. Second, there is a need for in depth feedback related to design of the features and functionality of the product. This type of research necessitates working with a small number of users, observing their device use, and gaining immediate feedback on design features. Chisnell (2009) pointed out that the greatest value of testing comes from closely observing and listening as people interact with a technology or design.

Finally, future testing needs to be lighter and faster, as Chisnell (2009) emphasized. In the present study a literature review was conducted and a research method was developed for the initial usability test. Testing in the future could rely on the basic methods developed here, but it could be completed in more efficient time frames. The present research used a basic prototype, and it confirmed POC for the overall product and assessed desired top-level features. Future development efforts should emphasize a user-centered design for the interface, and rapid building and testing of expanded features to create a school-ready functioning product as soon as possible.

## Conclusion

The barrage of digital technologies for business, recreation, leisure, entertainment, health, and communication can feel overwhelming. Because social work has focused on face-to-face human interaction social workers may be somewhat reticent and behind the times in terms of researching, developing, and utilizing technology to understand and improve human wellbeing. Indeed, this need not occur in the future.

Social work has a history of working to understand and facilitate complex human interactions. The knowledge and skills related to research, policy, and practice are translatable to working at the interface of human behavior and digital technology. Importantly, social work values that are related to enhancing human wellbeing and advocating for social justice for marginalized groups are crucially needed in the area of technology design and use. Whether at the point of design and development, theory and knowledge building, or evaluating interventions, social workers must embrace technology as a field of practice.

The present study represented one venture integrating social work research with technology design and development. The pace of technology development far out strips the time it takes to complete a dissertation. This usability test was one step in facilitating the design of a technology that is well along the path of development. The technology has now been tested in several school settings, and whether or not it proves to be beneficial will be borne out over time. This research provided some initial answers to questions related to feasibility and usability of an initial prototype. A social worker's satisfaction comes from participating with others in taking incremental steps to benefit others. The authors hope is that this study contributed to the arduous process of developing a mobile technology to improve the organizational skills of children with attention-deficit/hyperactivity disorder and high-functioning autism spectrum disorder.

# APPENDIX A

# CONSENT AND ASSENT FORMS

**Consent and Parental Permission Document**

**BACKGROUND**

You and your child are being asked to participate in a research study. Before you decide to participate, it is important for you and your child to understand why the research is being done and what it will involve. Please take time to read the following information carefully and discuss it with friends and relatives if you wish. Ask the research leader or staff if there is anything that is not clear or if you would like more information. Take the time you need to decide whether or not to volunteer to take part in this research study.

The purpose of the study is to explore the usability of task tracking software application (ADD.it) for grade school students with ADHD. The ADD.it program runs on an iPod Touch. During the Camp Takoda academic schedule students will use iPod Touch devices to access educational games as part of the standard camp schedule. An early prototype of the ADD.it program will be put on the iPod Touches used by those children participating in this study. The ADD.it program is designed to help students keep track of their daily assignment and to reward them with "points" when they make the effort to record and complete homework/tasks. The earned points can be accessed during a 20-30 minute period during the Camp day and during the evening. The "points" are converted into minutes. The child may use the minutes to play age appropriate music, games, or videos on the iPod Touch. Thus, children receive immediate "reward" (points) when they do a desired behavior and longer term "reward" (minutes of play time on the iPod Touch) during nonacademic hours. As a parent you will be asked to observe and monitor your child's at home use of the iPod Touch. The researchers will gather information through observation and discussions with you, your child, and Camp Takoda staff. This is an early stage usability study to assess child interest and use patterns, gather parent input, and test the basic idea of the ADD.it application. This study is being conducted by a research team from the University of Utah College of Nursing (Jodi Morstein, PhD, APRN), College of Social Work (David Groot, MSW) and their research assistant.

**STUDY PROCEDURES**

1. All participants in Camp Takoda will be invited to participate in this study prior to the first day of camp. The study will take place week 2-8.
2. Parents will be asked to give consent and children will be asked for assent prior to the beginning of camp.
3. Parents and staff will receive an orientation to the ADD.it program and the iPod Touch before the study begins.
4. All children involved in Camp Takoda will receive orientation to the iPod Touch as part of the camp program. Those who participate in the study will also receive orientation to the ADD.it application during the first week of Camp.
5. Week 1 – iPod Touch will be used for "game time" 20-30 minutes during camp day
6. Week 2 - Those enrolled in the study will begin to use the ADD.it program during the academic time at camp and will continue to use the iPod Touch during 20-30

minute educational “game time." The use patterns of study participants will be monitored and tracked.

7. Week 3-5 – Study participants will use the ADD.it program at Camp Takoda and children may take iPod Touch home each evening. Parents will have access to the ADD.it website for additional support and communication. Play time on the iPod Touch during noncamp hours will be determined by earned points and will be monitored by parent.
8. Week 6-7 - Debriefing Groups with children, parents, and Camp Takoda staff will be facilitated. Researchers will ask participants to talk about features, strengths, weaknesses, difficulties, and suggested modifications for the ADD.it program.
9. Week 8 – Children will return the iPod Touch devices to the research team. Parents, children, and Camp Takoda staff will have opportunity to give additional input. Research team may contact participants to further clarify comments or concerns.

**RISKS**

The researchers do not anticipate any major physical or emotional risks as a result of this study. Minor potential risks include: Children may become frustrated or upset if the iPod Touch cannot be accessed during free play or in the evening because they have not earned “points” through recording and completing required tasks. Researchers anticipate this stress will be similar to and no greater than stress related to the other behavioral treatment components (reward and response cost) of the camp and typical child responses to parental limit settings.

The researchers understand that an iPod Touch may be lost or damaged in this study. If the iPod is lost, stolen, or does not function the child will continue with the Camp Takoda program using the standard task tracking protocol (verbal and written reminders of items to be sent home or brought to camp each day). If the iPod Touch is not useable a child who enjoyed the device might become frustrated.

Every effort will be made to maintain confidentiality of participants though researchers acknowledge that there is a mild potential risk of others learning that you and your child have been involved in this study.

**BENEFITS**

We cannot promise any benefits to you or your child for being in the study. However, possible benefits may include: enhanced communication between the academic program at Camp Takoda and home, and increased incentive for your child to record, take home, complete and return homework/tasks, increased focus for your child during school hours for task completion, an increased understanding of the types of rewards (games, music, videos etc.) that are motivating for your child.

The information gathered from this study will help us revise, refine and develop the ADD.it program which in the future may offer significant assistance, support and possibly a treatment intervention for children with ADHD in academic settings.

**ALTERNATIVE PROCEDURES**

You or your child may choose not to participate in this study. If you or your child do not want to take part in the study, your child will still have access to an iPod Touch during designated game times at Camp Takoda. If you or your child do not participate in the study the standard camp protocols for sending homework home, sending home other items and verbal reminders to bring the items back will be utilized each day.

**CONFIDENTIALITY**

Results of this study may be published, but your and your child's identity will not appear in any such publication. We will keep all research records that identify you and your child private to the extent allowed by law. Records about you and your child will be kept in a coded, password protected file on the protected University server. Only those who work with this study will be allowed access to your or your child's information. We will do everything we can to keep your records and those of your child private, but cannot guarantee this.

**PERSON(S) TO CONTACT**

If you feel you or your child have been harmed as a result of participation please call David Groot at (xxx) xxx-xxxx. David Groot can be reached at this number Monday through Friday from 8am to 5pm. You may also contact the Camp Director at Camp Takoda during camp hours who will facilitate a meeting with Jodi Morstein at your request.

**Institutional Review Board:** Contact the Institutional Review Board (IRB) if you or your child has questions regarding your or your child's rights as a research participant. Also, contact the IRB if you or your child have questions, complaints or concerns which you or your child do not feel you can discuss with the investigator. The University of Utah IRB may be reached by phone at (801) 581-3655 or by e-mail at irb@hsc.utah.edu.

**Research Participant Advocate:** You may also contact the Research Participant Advocate (RPA) by phone at (801) 581-3803 or by email at participant.advocate@hsc.utah.edu.

**VOLUNTARY PARTICIPATION**

It is up to you and your child to decide whether or not you and your child participate in this study. If you or your child decides to participate you and your child are still free to withdraw at any time and without giving a reason. Refusal to participate or the decision to withdraw from this study will involve no penalty or loss of benefits to which you or

your child are otherwise entitled. If you and your child don't take part, you and your child can still receive all of the standard care that is available to your child. If you or your child do not participate, it will not affect the relationship you have with the Camp Staff or Director.

**RIGHT OF INVESTIGATOR TO WITHDRAW**

The investigator can withdraw you or your child without your approval. Possible reasons for withdrawal include loss or destruction of the iPod Touch, or a child's behavior that is exacerbated or complicated by introducing this intervention. Researchers will meet personally and communicate directly with parents if there is any need to withdraw a child from this study.

**COSTS AND COMPENSATION TO PARTICIPANTS**

Tuition to Camp Takoda does not support this study. You will be paying full tuition for Camp Takoda. You or your child will not be charged, nor will your insurance company be charged, for any use of the iPod Touch, ADD.it program, interview or instruction that are completed solely for the purpose of this study.

Participants in this study will not be financially compensated. Children who participate will have the use of an iPod Touch for 8 weeks of this study. The iPod touch will be returned to the research staff at the end of the study period.

**NEW INFORMATION**

Sometimes during the course of a research project, new information becomes available about the intervention that is being studied. If this happens, your research staff will tell you about it and discuss with you and your child whether you and your child want to continue in the study.

If you or your child decides to withdraw at that time, your research staff will make arrangements for your child to continue in Camp Takoda using the standard treatment format for tracking homework and tasks. If you and your child decide to continue in the study, you will be asked to sign an updated consent form.

**CONSENT**

I confirm that I have read this consent and authorization document and have had the opportunity to ask questions. I will be given a signed copy of the consent and authorization form to keep.

I agree that my child and I will take part in this research study and authorize you to use and disclose health information about my child for this study, as you have explained in this document. I understand that my child has the right to choose not to participate and withhold assent.

_____
Child's Name

_____ _____ _____
Parent/Guardian Signature Relationship to the Child Date

_____ _____ _____
Parent/Guardian Signature Relationship to the Child Date

_____ _____
Name of Person Obtaining Authorization and Consent Date

**Assent to Participate in a ADD.it Usability Study**

**Who are we and what are we doing?**
We are from the University of Utah. We would like to ask if you would be in a research study. A research study is a way to find out new information about something. In this study we will be trying to find out what kids think about using a iPod Touch to help them keep track of assignments and tasks for school. We will want to know what you like and don't like about using the program we have created to help kids in school.

**Why are we asking you to be in this research study?**
We are asking you to be in this research study because we want to learn more about if kids would like to use an iPod Touch to help them keep track of assignments for school, remind them to bring their homework home and back and what kind of games, music, or other applications they would like to earn as rewards. We want to do this study to learn about ways we can help kids with ADHD with organization, keeping track of things they need to do, and homework.

**What happens in the research study?**
If you decide to be in this research study and your parent or guardian agrees then you will be able to use an iPod Touch with a program we call "ADD.it". The program has been pre-loaded on an iPod Touch that will help you keep track of homework and other tasks. The iPod will also have music for kids and a few games you can play as a "reward" when you have earned points for completing the assigned tasks.

1. We will give you an iPod Touch to use for the 8 weeks of this study. After the study you will give back the iPod so we can use it again in studies in the future.
2. We will ask you to take good care of the iPod Touch.
3. We will teach you how to use the iPod Touch, the program for this study and other features.
4. We will ask you to bring the iPod Touch to camp each day and use it to help you track your assignments, tasks, and homework.
5. We will explain the program and iPod Touch to your parents and ask for them to also give us information about what they observe.
6. We will watch how you use it and ask you questions about what you like about the program.
7. We will ask the Camp Takoda teacher and staff about what they observe when you use the iPod Touch.
8. You will be in the study for 8 weeks.

**Will any part of the research study hurt you**?
There is a chance that during this research study you could feel frustrated about using or not using the iPod Touch. There will be times during camp that you will not be able to use the iPod Touch and you will be doing other things. We will try to explain how and when you can use it both at camp and at home. You can stop participating in the study at any time and give us back the iPod Touch.

**Will the research study help you or anyone else?**
We do not know for sure if being in this research study will help you with your homework or tasks. We think it is possible that what we learn from this study will help us develop a program that may help many kids with ADHD in the future.

**Who will see the information about you?**
We will not tell anyone about your participation in this study besides your parents, the staff and teacher at Camp Takoda.

**What if you have any questions about the research study?**
It is okay to ask questions. If you don't understand something, you can ask us. We want you to ask questions now and anytime you think of them. If you have a question later that you didn't think of now, you can ask Jodi Morstein or David Groot at Camp Takoda.

**Do you have to be in the research study?**
You do not have to be in this study if you don't want to. Being in this study is up to you. No one will be upset if you don't want to do it. Even if you say yes now, you can change your mind later and tell us you want to stop. You can take your time to decide. You can talk to your parent or guardian before you decide. We will also ask your parent or guardian to give their permission for you to be in this study. But even if your parent or guardian say "yes" you can still decide not to be in the research study. You may attend and participate in Camp Takoda even if I decide not to be in this research study.

**Agreeing to be in the study**
I was able to ask questions about this study. Signing my name at the bottom means that I agree to be in this study. My parents or guardian and I will be given a copy of this form after I have signed it.

_____
Printed Name

_____ _____
Sign your name on this line Date

_____
Printed Name of Person Obtaining Assent

_____ _____
Signature of Person Obtaining Assent Date

The following should be completed by the study member conducting the assent process if the participant agrees to be in the study. Initial the appropriate selection:

_____ The participant is capable of reading the assent form and has signed above as documentation of assent to take part in this study.

_____ The participant is not capable of reading the assent form, but the information was verbally explained to him/her. The participant signed above as documentation of assent to take part in this study.

# APPENDIX B

# CHILD AND PARENT DAILY LOGS

**Child Daily Usage Log** Day #_____ Date: _____

Notes/Comments:

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | |
| Child Present Y/N | | | | | | | | | | | |
| Brought iPod Y/N +50 | | | | | | | | | | | |
| iPod used for tasks? Y/N | | | | | | | | | | | |
| Used before arrival? Y/N | | | | | | | | | | | |
| **Checklist/brought:** | | | | | | | | | | | |
| Back Pack +2 | | | | | | | | | | | |
| Swimsuit +2 | | | | | | | | | | | |
| Towel +2 | | | | | | | | | | | |
| Ball Glove +2 | | | | | | | | | | | |
| Lunch +2 | | | | | | | | | | | |
| Daily Report Card +2 | | | | | | | | | | | |
| Homework +5 | | | | | | | | | | | |
| iPod Bring Back Points | | | | | | | | | | | |
| Parent Survey Y/N | | | | | | | | | | | |
| iPod Take Home Points | | | | | | | | | | | |
| Total Extra Points | | | | | | | | | | | |
| | | | | | | | | | | | |
| **4:25 Alarm** | | | | | | | | | | | |
| Used PM task list? Y/N | | | | | | | | | | | |
| Looked for items Y/N | | | | | | | | | | | |
| | | | | | | | | | | | |

**Parent Daily Usage Log** Child: _____ Date: _____

**Afternoon Take Home Checklist**

| Yes | No | Did your child bring home their: (mark an X on "yes" or "no") |
|---|---|---|
| | | |
| | | Swimsuit |
| | | Towel |
| | | Softball Glove |
| | | Homework |
| | | Lunch box |
| | | Field trip point card |
| | | Daily report card |

**iPod Touch Evening Use Questions**

_____ **Yes** _____ **No** Did your child use their iPod for a daily reward related to camp? (If "no" skip to the question marked with this arrow) ➡

If you answered, "Yes" to the question above about how many minutes did your child play with it? (enter in the box) ☐

How motivated was your child to use the iPod as a reward? (circle one below)

**Not at all** **A Little** **Somewhat** **Highly**

➡ _____ **Yes** _____ **No** Did you allow your child free play time with their iPod?

If you answered "Yes" to the question above about how many minutes did they play with it? (enter in the box) ☐

How motivated was your child to play with the iPod? (circle one below)

**Not at all** **A Little** **Somewhat** **Highly**

**Morning Questions**

_____ **Yes** _____ **No** Did your child use the iPod morning checklist to check off the things they needed to bring to camp?

How did your child get the things they needed for camp packed? (circle one)

**Independently** **With Some Help** **Parent Packed Items**

# APPENDIX C

# CHILD AND PARENT SURVEYS

**Kids Survey: The iPod Task List**

| | Not Important | A little Important | Somewhat Important | Important | Very Important |
|---|---|---|---|---|---|
| (1) The iPod has a checklist that reminds me what to bring and take home. | | | | | |
| (2) I can wear my iPod on an armband or belt clip and carry it with me. | | | | | |
| (3) The iPod reminds me with alarms or vibrations when I need to do something. | | | | | |
| (4) I can have all of my classes (math, reading) listed on my iPod | | | | | |
| (5) The iPod links to my teacher's computer so I know I have my assignment right | | | | | |
| (6) I get a cartoon or animation when I enter something right. | | | | | |
| (7) I get points for game time when I enter an assignment right. | | | | | |
| (8) I get points for game time from my teacher when I hand in an assignment | | | | | |
| (9) I get extra points when I get a good score on an assignment | | | | | |
| (10) Sometimes I get surprise points when I enter an assignment or complete a task. | | | | | |
| (11) All of my points are turned into minutes of game time on the iPod | | | | | |

| **Parent Survey: iPod Features** | Not Important | A little Important | Somewhat Important | Important | Very Important |
|---|---|---|---|---|---|
| Students can wear their iPod on an arm band or belt clip | | | | | |
| Student iPods can be pre-loaded with their class schedule | | | | | |
| iPod can prompt students with alarms or vibration when the need to remember tasks/items | | | | | |
| iPod will be limited to application only during school time | | | | | |
| When tasks or assignments are entered my child will earn points | | | | | |
| My child's iPod will "sync" with the teachers computer/gradebook | | | | | |
| My child's teacher will validate that my child got his/her assignment entered right | | | | | |
| I can access teacher communication/grades through a website and my smartphone | | | | | |
| I can view grades and what is on my child's iPod through a website | | | | | |
| I can communicate with my child's teacher through the program/website | | | | | |
| My child will earn points for turning in assignments | | | | | |
| My child will earn extra points if assignments are accurate | | | | | |
| The iPod will sometimes give extra points as surprise rewards | | | | | |
| The iPod has a calendar and daily, weekly, monthly, assignment due dates | | | | | |
| The iPod will have daily alarms for before school reminders and end of the school day reminders | | | | | |
| The iPod will have a checklist for things for my child to take to school and bring home each day | | | | | |
| The iPod will have flexibility so I can enter other activities and tasks | | | | | |
| I have control over my child's iPod in terms of what games, sites, may be accessed | | | | | |
| The website will offer additional information such as tips for dealing with children with ADHD | | | | | |

# APPENDIX D

# FOCUS GROUP QUESTIONS AND RESPONSES

| **Parent Focus Group Preliminary Questions** | | | |
|---|---|---|---|
| What was valuable to you and why?<br>What did not work or was not helpful?<br>What was your experience with using the device with your child?<br>What are you hearing from you kids related to use of the device?<br>What features and functions would you like included in a fully developed mobile technology? | | | |
| **Second Parent Focus Group – Responses** | Coding | | |
| | DG | JM | KG |
| F: First question: What was valuable to you and why?<br>P: It was an instant motivator to the kids, I mean it was an instant motivator to do well. It helped him to change his behavior and what we found is he could control his level of behavior that allowed him | GM | GM | GM |
| F: What was it that motivated him?<br>P It was the device that motivated him, he wanted the game time, and that was far more motivating to him then I will get you an ice cream, or better than hearing you are going to be in trouble if you do not do well, so the positive motivation was better than anything else. | GM | GM | GM |
| F: So why did he care to have the time on the iPod Touch<br>P: Because it was his own deal, he got to say to his brother, 'look I've got an iPod, ha, ha' He was very proud of his little iPod, he got to show it off. | VP | VP | VP |
| P: I think it's the actual tool, the iTouch, it's that little black rectangle that you get to have, so it's the novelty of having that toy. | RN | RN | RN |
| P: So I would say if it had some type of Youtube filter in there, he would be totally on top of that, because when he wrote the letter he kept saying, when are you putting Youtube on it – I want Youtube. | RN | FF | RN |
| P: For my son it was an ownership thing – it was far more cool to him to than playing on the phone or some other thing because it was his deal. The ownership was a big deal to him? | VP | VP | VP |
| P: I think with mine, it was a control thing because she was in control of getting it herself. I wasn't the one giving it to her, she had to do the task, and go through the directions. I just put them up there and she followed them. So it was under her own self-control, it wasn't like I was controlling it, so it was all up to her, so when she got it, she'd only play it for 5 minutes then she was done because there weren't games she wanted on it, she wanted her own stuff. I think it was the self-control issue that motivated her. | RP | RP | RP |
| P: I'd say the same was the case in our house. It didn't have the music that he liked and the games he wanted. If he had his own that he could put things on and add things to it, it would be more motivating. | RP | RN | RN |
| F: Is there anything to having the instant reward of the game?<br>P: I will just tell you what I did as a parent to motivate him to use it. I took away his DS, and I took away his Wii, and I said this is going to be your form of entertainment for now, and if you do not earn it, then you do not earn it, so to motivate him to use the program and learn the benefit of using the program. | PC | PC | PC |
| P: Our son thought it was cooler to log his homework into an iTouch than a planner, so much like, … he was very consistent and I did not have to ask him, but he was very consistent and I did not have to ask him, he would go write in and do his homework, log it in the iTouch and put it away in his backpack, and that worked for him, far better than the planners that the school sends home that I cannot even use. | SM | SM | SM |
| P: My son would use it, but he likes it better now that you have added new games. I think it needs more novelty. | RN | RN | RN |
| P: My son was the same. At first he wasn't that interested, but now that he has games he likes, he is using it more. | RN | RN | RN |
| | | | |

| | | | |
|---|---|---|---|
| P: At first my daughter used the checklist. And, now I think it is just routine and boring for her. | RN | RN | RN |
| P: My son plays and then he keeps asking, "Do I have more time? Is my time up, so it would be nice if it kept track of time. | FF | FF | FF |
| P: What about a daily update where the kids homework is uploaded into the iPod by the teacher? | FF | FF | FF |
| P: I think it needs an alarm to go off in the morning. Because right now I have to remind him to use it. | FF | FF | FF |
| P: It would good if we could see the checklist before he comes home, because he still comes home without things. | SM | FF | FF |
| F: What are you hearing from your kids?<br>P: My son doesn't want camp to end because he knows he will have to give his iPod back | GM | GM | GM |
| P: He doesn't even care what games are on it – he just likes playing with it so much | GM | GM | GM |
| P: As a parent will I be able to have a password to control when he gets it, and could I go in and change the amount of game time or things like that? You know could I go on and add additional time. | FF | RN | FF |
| P: I like the idea that I could go in and enter other tasks, and then if I want give additional rewards. | FF | RN | FF |
| P: We are using it as a reward where he can't play it in the car on the way unless he is ready on time, and he can't play it at home until he has done and checked off his homework. So, he has only been late once now. | GM | RN | RN |
| F: How is the homework entry working?<br>P : I can't ever remember my son recording an assignment in a planner | SM | SM | SM |
| P: I was in absolute shock that he was doing it homework. It was incredible, that I wasn't instigating it. | SM | SM | SM |
| F:So for the future would you as a parent liked to receive a notice on your phone when they turned in their homework?<br>P: Yes, like anything they do on that thing with planning I'd like to see it. | FF | FF | FF |
| F: Did you have any trouble monitoring the use of the device?<br>P: My son would get in the car and say, 'mom, mom, I wanna show you my iPod, I wanna show you all the games, and I'd be driving, and trying to tell him to put it away, and by the time we got home we'd already fought over the thing, and even trying to get him to turn it off when his time was up, I wish there was a timer or something, a limited amount of time where he had to turn it off. | FF | FF | FF |
| P: Yes, that's what we need, or something where we have to log in and set the time. | FF | FF | FF |
| F: Thank you, those are things that are planned, but we want to hear from you.<br>P: If you can make that happen, where you set the time, I want that for every electronic device in my house. | FF | FF | FF |
| F: You know that is possible. It could be a remote for every electronic device.<br>P: This may be a little bit ahead, but while were talking about the programming, will the program ever be able to used on other devices, so that whatever smartphone you already own, could this be downloaded as an application? | FF | FF | FF |
| P: One thing that is nice about the iTouch is it is something that is socially cool, so my kid has to get things signed off, and if it could be done on the iPod then he would not be marginalized, because it is a cool thing. | VP | VP | VP |
| P: It would be good to communicate directly to the teacher. | FF | FF | FF |
| F: If we can't turn the device off and blue screen it during school, or have it turn off after a set amount of minutes – has it lost it's value?<br>P: Yes, if my son could play video games in class it would lose it's value – too distracting. | RN | FF | FF |
| | | | |

| | | | |
|---|---|---|---|
| P: If my son was motivated by it, I suppose it would be okay. The bottom line for me is I saw that it motivated my son to do better | GM | GM | GM |
| P: If my son knew when he was supposed to be entering an assignment, he could also go in and play games, he's not likely to walk away from that. | FF | FF | FF |
| P: For me the organizing is a step forward. Because right now he never uses a planner. And he will use it because he likes it. So I could manage how much time he has to use it. | SM | PC | SM |
| F: So what about you determining the rewards your child gets?<br>P: Yes, because I would like to give my son other things like maybe going to a movie, or even earning money to download a game, or going to a game or things like that. | FF | PC | FF |
| F: What if at the point they redeemed points for time, a timer would start, and then an alert would pop up when their time was about up?<br>P: Could you just make everything password protected so when we get an alert, then we could send our kid a password to play, or when we get on their device we just need to enter a password. | FF | FF | FF |
| P: I think the novelty will at some point wear off, so you'd need to have ways to update things like rewards. | RN | RN | RN |
| | | | |
| **First Parent Focus Group Reponses** | | | |
| P: "You've got good games now" | RN | RN | RN |
| P: "Right now, I think you have good game motivation." | RN | GM | RN |
| P: "I agree, for a few weeks it did not seem like it had much impact, but finally he was excited last night to play." | GM | GM | GM |
| P: "[He] is doing his homework and this is the first time he has ever done that." | GM | SM | GM |
| P: "[He] does the checklist in the morning and his motivation is getting points for camp. But it does help him to remember his backpack and collect things in the morning." | GM | GM | GM |
| P: "[He] does not care, as long as there is a game on there, he is motivated to play with it. I do not even know what he is doing with it half the time, but he just wants to play the games." | GM | RN | GM |
| P: "I just wanted to let you know that we are using the IPod Touch, where he can't use it on the way to camp unless he walks out of the door on time, and he has only been late once since, and before that it was three times a week easily She went on to add, "then on the way home he has to do his homework first, and then when he gets home he has to go through the checklist that I made up where he has to hang up his towel, and take care of a few other little chores … and it is amazing the difference that it has made at home." | PC | PC | PC |
| P: Another parent then commented, " just a quick idea is that different kids will have different needs … and will it be possible to customize for each kid?" This was confirmed as part of the plan for the software. | FF | FF | FF |
| P: Another parent commented, "just a thought about the software is if you have a set amount of game time per evening, but then if you have something come up on the weekend, maybe the child should have the choice of whether they save the time or use it." | FF | FF | FF |
| P: "Do you think it would work to have rewards that include not playing on the IPod?" Another parent said, "so what if you could create a menu of rewards, like so many points equals a trip to go play at the park or something." | RN | FF | FF |
| P: One of the parents then commented that, "one of the things I was thinking about was when we talking about banking points for the weekend, if we came up with points required for something else, like and electric scooter, would there be a way to create a 'savings account' for points to be for something like that?" She added, "you know, you tell the child you can take half your points and put them in a savings account toward a scooter or something." | FF | FF | FF |
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| P: "How will this work this fall in school?" When it was explained the software is only a prototype for this study, the parent expressed disappointment because, "this has helped her keep track of things better than anything else I have tried." | SM | SM | SM |
| | | | |
| **Children's' Focus Group Preliminary Questions** | | | |
| Did you like using the iPod for checking things for camp? What did you like about it? Not like?<br>What do you think would make the iPod better for tracking things at home and in regular school?<br>What do you think about the idea of being rewarded with game time for remember things?<br>What are all the ideas you have to make the iPod better for helping kids track and remember things? | | | |
| **Children's Focus Group Responses** | | | |
| F: Was the iPod tasklist helpful or not helpful for keeping track of things this summer?"<br>C: "I think maybe it helped a tiny bit, but it didn't help that much, but I think if you added some stuff it might help more." | GM | GM | RN |
| C: "I don't think it helped me at all. Hey, can you put *Pocket God* and *Angry Birds* on it for next week?" | GM | GM | GM |
| C: ""I think it helped me a lot because I am usually forgetting things, and every time I would see my IPod in the morning I would say, Oh I just remembered I forgot to do my checklist." She added, "And when I did the checklist it let me know I had all of my things." | SM | VP | SM |
| C: "Mainly it did not help me, but I would usually almost forget my homework and report card, but once we started the IPod thing it helped me remember those things." | SM | SM | SM |
| C: "I would not be able to remember that much, so it really helped me." | SM | SM | SM |
| C: "I think if it was more game like it would be fun, so maybe, like maybe each time someone does their checklist you could add a game to their IPod." | GM | GM | GM |
| C: "I think it would help if it was a fun checklist, because then you also would be happy at camp because you have everything you need." | RN | RN | GM |
| F: What about the idea of an alarm as a reminder?"<br>C: "It would help, because if you have to get up at a certain time it would vibrate." | SM | FF | SM |
| C: "With that kind of thing I would probably usually forget, but if it vibrates, I would remember it." | SM | SM | SM |
| C: "Well especially if it kept vibrating until I would do it, and then I could turn it off, but sometimes I might get distracted and just turn it off, and not do it anyway." | SM | SM | SM |
| F: What about the idea of a class list?"<br>C: "I think it would help because I am just really forgetful sometimes, and it would help me remember things." | SM | SM | SM |
| C: "So you were saying you would maybe make it into a game, do you mean like if we do our homework it would do something to get you further along in a game, like it would be intertwined with a game, or like you would advance a level or something?" | GM | GM | GM |
| C: "Do we get to take your IPods home to keep?" When I explained once again they belong to the University of Utah, she responded with a mild, "dang it." | GM | RN | GM |
| C: "I think it would be important because when you did it [an assignment], it would be nice to have some game time because where I was at in school I got something [a reward for completing and assignment]." | RN | GM | RN |
| C: "like if you get extra points, like if you got all of your academic points you | RN | GM | RN |

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| could do half of that as minutes of game time? "I put that as 'important.'" | | | |
| C: "I don't get what you mean, do you mean just like random points?" I explained that the points could vary and be surprises of various amounts. He said, "I would like that." | RN | RN | RN |
| F: "Is there anything else from using the iPod this summer whether using the checklist or having time to play with it in class that you would like to say?" C: "So at the University of Utah, where will the IPod's be? And, if I come for UFit, I wonder where the IPod's will be, I wonder if I could maybe play with one?" | GM | GM | GM |
| | | | |

**Themes from Parent and Child Focus Groups**

SM = Self-Management with Parent Support

VP = Valued Possession and this Facilitates Use

RN = Reward Value Varies and Depends on Novelty

PC = Parent Established Contingencies are Helpful

FF = Feature Flexibility for Parent Monitoring and Management

GM = Game-Like Motivates for Use and Success

**Additional Qualitative Responses & Theme from Parents**

At the close of the second parent meeting: Parent: "So with the iPod how will we use it this fall after camp?" This author explained the goal was to take all of the data and help parents provided and seek additional funding to further develop the software. The parent added, "Oh, So we have to have a plan B for 7th grade because we won't have this to help?"

P: "How will this work this fall in school?" When it was explained the software is only a prototype for this study, the parent expressed disappointment because, "this has helped her keep track of things better than anything else I have tried."

**Theme: We need it now: An urgent need for help**

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| **Child Responses in the Morning Recorded on Child Daily Logs** | |
| "I did my checklist before I came." | SM |
| "I used it at 7:40" | SM |
| "I played with it in my sisters car, then my mom took it, now it's in my mom's car." | LF |
| "I used it this morning." | SM |
| "I checked things off when I was in the car." | HJ |
| "It's at home." | LF |
| "I think I left it in my Dad's car … I don't know where it is." | LF |
| "Yes, I used it to think about each one of my things | SM |
| "My mom always says 'check' when I check off my things." | SM |
| "I forgot my backpack in the car, it's in there." | LF |
| "I left it at my babysitters house." | LF |
| "I used the checklist in the car." | HJ |

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| "My grandpa does the iPod and I check for things." | SM |
| "I always know I have everything except two things, and Poppy tells me if I have those and I check them off." | SM |
| "I did it right at the breakfast table." | HJ |
| "I did it last night." | HJ |
| "I couldn't do it this morning because my iPod died." | |
| "A counselor told me I didn't need to take it home." | |
| "I couldn't find it so I couldn't do it." | LF |
| "I did it this morning with my Dad." | SM |
| My mom checked off everything." | SM |
| "I like the checklist, but only because of the fun things, like I said next time add *Pocket Gods."* | |
| "Hey guess what? I made it to the 21st level on *Angry Birds*." | |
| "My mom forgot my bag, I'll just play *Bionicles* during game time." | LF |
| "I forgot to do it, can I do it now and still get game time?" | LF |
| "I did it this morning, I don't think it helps much." | SM |
| "I left my iPod on my nightstand." | LF |
| "My mom forgot my bag, I forgot to do my homework so 'No.'" | LF |
| | |
| **Themes for Child Log Comments** | |
| SM = Self-Management with Parent Support<br>HF = Hurrying and forgetting lead to nonuse<br>HJ = Hoop jumping to complete the task | |

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